

EXPERIMENTAL
ESSAYS

ON

MEDICAL and PHILOSOPHICAL

SUBJECTS:

PARTICULARLY,

- | | |
|---|---|
| I. On the Fermentation of Alimentary Mixtures, and Digestion of Food. | IV. On the Scurvy; with a Proposal for trying new Methods to prevent or cure the same, at Sea. |
| II. On the Nature and Properties of Fixed Air. | V. On the Dissolvent Power of Quick-Lime; and a further Investigation of the Properties of Fixed Air. |
| III. On the respective Powers, and Manner of Acting, of the different Kinds of Antiseptics. | |

The THIRD EDITION, ENLARGED and CORRECTED.

Illustrated with COPPER-PLATES.

By DAVID MACBRIDE, M. D.

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EXPERIMENTAL

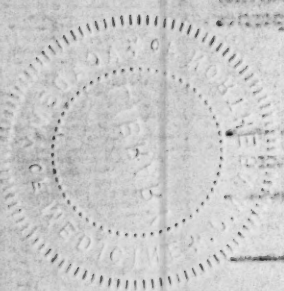
ESSAYS

MEDICAL AND PHYSIOLOGICAL

SUBJECTS

PART I. GENERAL

On the formation of Air. On the nature of the
respiratory process, and the influence of
the atmosphere on the human system.
On the nature and properties of the
respiratory organs, and the influence of
the atmosphere on the human system.
On the nature and properties of the
respiratory organs, and the influence of
the atmosphere on the human system.



THE PHYSIOLOGICAL, EXPERIMENTAL, AND
MEDICAL, AND THE PHYSIOLOGICAL

BY DAVID MACGILLIVRAY, M.D.

LONDON:
Printed by T. Baskin, and T. C. Baskin, in the Strand.
1844.

The wonderful and secret Operations of Nature are so
involved and intricate, so far out of the Reach of
our Senses, as they present themselves to us in their
natural Order, that it is impossible for the most sa-
gacious and penerrating Genius to pry into them,
unless he will be at the Pains of analysing Nature
by a numerous and regular Series of Experiments,
which are the only solid Foundation whence we may
reasonably expect to make any Advance in the real
Knowledge of the Nature of Things. *Hales.*

The wonderful and secret Operations of Nature are
involved and intricate, so that the Reason of
our Species, as they present themselves to us in their
natural Order, that it is impossible for the mind to
fathom and penetrating Science to give into them
unless he will be at the pains of studying Nature
by a numerous and regular Series of Experiments
which are the only solid Foundation whence we may
reasonably expect to make any Advance in the real
Knowledge of the Nature of Things. *Alas*

TO THE RIGHT HONOURABLE

SIR CHARLES SAUNDERS,
KNIGHT of the BATH, VICE-ADMIRAL of the WHITE, one of his MAJESTY'S Most Honourable PRIVY COUNCIL, &c.

S I R,

IT may perhaps seem strange, that a name so eminent for military achievements, should be prefixed to a book which promises to treat only of subjects peculiar to the medical profession; but the propriety of this dedication will be readily allowed, when it is told, that you were pleased to give your sanction to the proposal, which is therein contained, for trying new methods of managing the scurvy at sea.

vi DEDICATION.

THAT memorable voyage round the world, which was no less remarkable for the variety of fortune attending it, than for the number of excellent officers it produced, gave you an opportunity of beholding this destructive disease rage with uncommon degrees of violence; hence, no doubt, every rational attempt to prevent or alleviate the like distresses for the future, must necessarily engage your attention.

You will now be pleased to hear, that the experiment which I proposed, has actually been made; and to see, from the Postscript annexed, that it bids fair to answer what was expected from it. Permit me, therefore, to request the
conti-

DEDICATION. vii

continuance of your protection, in order that this scheme may be still further pursued, since there is so much reason to hope, it will end in establishing the practice, with respect to the disease in question, on such a safe and easy plan, as will be the means of preserving a most important set of men. I have the honour to be,

S I R,

Your most obliged,

and most obedient,

humble servant,

Dublin, 9th June,
1767.

DAVID MACBRIDE.

DEDICATION

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order that this scheme may be still
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SIR,

Your most obliged,

and most obedient

humble servant,

DAVID MACBRIDE.

T H E
P R E F A C E.

THE general purpose of the following Essays is to shew, that there is a principle in matter, which, hitherto, has not been much attended to ; and that this principle, forming the cement, or bond of union, among the insensible particles, is to be held as the immediate cause of firmness and perfect cohesion in those bodies, wherein it enters the composition, and is to be regarded as the thing that prevents their dissolution and decay.

It being the author's intention to apply this doctrine particularly to medicine, he begins his investigation by tracing the progress of digestion, and shewing that the principle

x The P R E F A C E.

principle above hinted at, is received into animal bodies, by the way of the chyliferous canals; and this makes up the subject of the first essay, and of some part of the second.

This point being proved by a number of experiments, and illustrated by some practical observations, he goes on to shew, from experiment also, that animal substances become putrid from the loss of the above-mentioned principle; seeing, that putrefaction is found to arise from the resolution and disunion of the several constituent particles; and offers a new theory for explaining the immediate cause of that degree of putrefaction, which often takes place in the living body. Here an opportunity is taken of introducing some experiments, in order to determine whether or not putrid animal substances
are

The PREFACE. xi

are to be regarded as alkaline : and it appearing from these that such substances are in reality of an alkaline nature, and that some writers of very great note have been misled into a contrary opinion, probably from observing that alcalies resist putrefaction ; he then proceeds, in the third essay, to examine experimentally, the power of antiseptics in general ; and finds that this depends, for the most part, on restraining the flight of the cementing principle.

AN enquiry then commences concerning the power of different things to restore soundness and sweetness to substances already putrid ; and it is shewn likewise from experiment, that this may be accomplished by restoring the cementing principle.

THIS naturally leads to a consideration of the most effectual methods

xii The P R E F A C E.

thods of curing putrid diseases, which is alledged to depend greatly on the application of such things as are known to be capable of furnishing a large proportion of the principle so often mentioned; and this is particularly exemplified in the cure of the sea-scurvy; a disease wherein the mass of fluids is evidently in a state of putrefaction.

IN consequence of this hypothesis, a proposal ensues for trying new methods to prevent or cure the scurvy, at sea; and this affords matter for a fourth essay, to which is annexed a very accurate account of that most destructive disease, extracted from the writings of JOHN WOODALL, an old English surgeon, whose works seem to be but very little known.

THE fifth essay contains a number of miscellaneous experiments and observations, all tending to a
further

The P R E F A C E. xiii

further proof of what I have advanced in the four preceding ones; and, moreover, lays down easy and expeditious methods of dissolving, in water, camphor, and all kinds of resinous substances.

THE foundation of the foregoing doctrine having been laid near forty years ago, by the celebrated Dr. HALES, and, of late, much improved by Dr. BLACK, (late Professor of Medicine at Glasgow, but now of Chemistry at Edinburgh) it will be proper that the reader be thoroughly acquainted with the Analysis of Air, in the first volume of HALE'S Statics; and with the experiments on Magnesia, in the second volume of the Edinburgh Physical and Literary Essays; as also with the experiments made by Sir JOHN PRINGLE, and which are to be found in the Philosophical Transactions, or in the Appendix to that learned Physician's

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an's Observations on the Diseases of the army; the following papers being designed as a sequel to all the three writers just now mentioned.

THE favourable reception of the first Edition has engaged the Author to revise this in the most careful manner, and to make such alterations and additions, as he hopes will render his labours still more acceptable; particularly, there is an experiment added to those of the second essay, which may be looked on as conclusive with respect to the theory of putrefaction; and there are others added to the fifth, in order to illustrate further the properties of that principle, which is the general object of the whole performance.

In the appendix to the fourth essay, there are some extracts of letters, and other papers concerning the methods proposed for treating the Scurvy at Sea.

ESSAY

ESSAY I.

ON THE

FERMENTATION

OF

ALIMENTARY MIXTURES.

THE
*The main business of natural philosophy is to
argue from phenomena, without feigning
hypotheses.* NEWTON.

ALIMENTARY MIXTURES.

ESSAY I.

ON THE

FERMENTATION OF ALIMENTARY MIXTURES, &c.

THE old chemists believed, that all the true spontaneous changes of bodies, were the effects of fermentation; and *Boerhaave* once held the same opinion*, though he afterwards came to restrain it within very narrow limits, and would suffer nothing to be called Fermentation which did not produce either an ardent spirit, or an acid; thus entirely confining it to what are usually called the *vinous* and *acetous* stages, and altogether rejecting the *putrefactive*, as looking on putrefaction to be a quite different process, and no way allied to fermentation.

BUT this restriction, which was meant for the sake of clearness and precision, has

* Prælect. Academ. in Sect. 256.

rather introduced confusion, with regard to the term putrefaction. This word, in its common acceptation, is always understood to imply a plain tendency to destruction in bodies, accompanied with every sign of rottenness and offensiveness: and, accordingly, we often meet with it in writers, in this sense, when perhaps, in the very same page, we shall be told, that the aliment is prepared for nourishing the human body by putrefaction; that motion and heat are communicated to the fluids by putrefaction; and that nature throws off morbid matter from the constitution by the means of putrefaction.

THE later chemists, therefore, who have reduced this branch of natural philosophy to a more intelligible and methodical system, than that of the great man just now mentioned, approach nearer to the ancient opinion, and define fermentation to be an
“ intestine motion, which arising spontaneously among the insensible parts of a body, produceth a new disposition, and a different combination of those parts.”

FROM this definition, it is plain, that a great number of the natural changes which daily take place in the animal and vegetable

ble kingdoms, should be looked on as so many modes of fermentation; and that, in particular, the digestion of our food ought to be regarded as a fermentatory process.

THE experiments already made by Sir *John Pringle*, seem sufficient to convince every unbiassed reader of the truth of this theory; which, if we consider the matter with any degree of attention, we shall find to be absolutely necessary, in order to bring about that new disposition, and that different combination, of the insensible parts of the alimentary substances, which enable the immense variety of discordant mixtures that enter the composition of our food, to depart so far from their original natures as to become one mild, sweet, and nutritious fluid; for this demands a great deal more than mere mechanical mixture and dissolution, which is the most that the common theories * of digestion extend to; since they do not seem expressly to require, nor

* Here we must except *Hoffman's* theory; for he insists much on the compleat change that the aliment undergoes in the first passages; and makes digestion a mere fermentatory process; as may be seen at large in his chapter *de Alimentorum Solutione & Salivæ Usu*, and the three succeeding ones.

indeed suppose, such an absolute change to be wrought, in the first passages, on the nature of the different kinds of food as would enable them to become, so soon as we see they do, one and the same substance with the body into which they are received.

It also appears pretty plain, from Sir *John's* experiments, that there is somewhat generated, or set free, during the *first stage* of the fermentation of animal and vegetable mixture, which hath a power of correcting putrefaction. But, in order to obtain still further proofs concerning this particular point, as well as to gain a more thorough knowledge of fermentation in general, I determined to repeat some of the doctor's experiments, and to try such others as I thought had the greatest tendency towards an illustration of both.

To fulfil these intentions, I made up the six following mixtures:

1. Bread and water, about four ounces.
2. Bread and boiled mutton, beat up thin, with the requisite quantity of water; in all about four ounces. This was called the simple fermentative mixture.
3. Four ounces of the simple fermentative

Table I. Of ALIMENTS

Mixtures of	At the end of 6 hours.	At the end of 22 hours.	At the end of 30 hours.
(1) Bread and water.	Shews no sign of intestine motion.	Still remains perfectly quiet.	Still at rest.
(2) Bread, mutton, and water.	Fermentation fairly begun; smell of the mixture perfectly sweet.	Fermenting now very briskly.	Brisk; the smell of the mixture perfectly sweet, and a little pungent.
(3) The same, with fresh juice of lemons.	In brisk fermentation; perfectly sweet; smell of the lemon just perceivable.	Very brisk; immersed a small bit of putrid mutton in this mixture.	Brisk; no smell perceivable in the mixture, but a little of the putrid mutton, but not of the mixture.
(4) The same, with spinage.	In brisk fermentation; a heavy kind of sweetish smell, not unlike that of the fenugreek seed.	Very brisk; suspended a little bit of putrid mutton in the phial, so as not to touch the mixture.	Brisk; no smell perceivable, but a little bit of mutton, but not of the mixture.
(5) The same, with water-cresses.	Motion not so brisk as in the two last, but considerably more so than in the simple mixture; smell of the herb but barely perceivable.	Very brisk; poured half an ounce of fresh ox-gall into the phial.	Not so brisk as in the morning; perfectly sweet.
(6) The same, with some putrid animal liquor.	Motion greater in this phial than in any of the others, with a thick scum and froth on the surface; not the least ill smell to be perceivable, tho' the putrid liquor was exceedingly offensive when first added.	Very brisk; tho' in the coldest place of all the phials. (Every one of the mixtures were now perfectly sweet, and had lost the peculiar smell of the herbs, &c.)	Brisk and sweet.

MENTARY MIXTURES.

End of 30 hours.	At the end of 46 hours.	After 54 hours.	At the end of 4 days.
Still at rest.	Still at rest.	Still at rest.	A sourness now perceivable.
The smell of the perfectly sweet little pungent.	Brisk and sweet; much froth at top.	Brisk and sweet.	Fermentation appeared to be now very near over; liquor sweet both to the smell and taste.
No smell now perceptible in the bit of mutton, but that mixture.	Still fermenting; the liquor clear and sweet; removed the bit of mutton and hung it up to dry, it being perfectly sweet.	Motion stopt; the bit of mutton dried and sweet.	Distilled this mixture; an almost insipid phlegm, with rather a vinous, than an acid taste, was the produce.
No smell in the mutton, but that mixture.	Fermentation appeared to be almost over; liquor clear and sweet; removed this and the phial with lemon-juice, to a cool place, and corked them close; hung up the mutton.	Motion stopt; the bit of mutton dried and sweet.	The smell of this mixture, before distillation, was a little inclinable to the cheesy, and the phlegm obtained by distillation had a small degree of pungency, with the same rancid flavour.
Brisk as in the first; perfectly	Liquor clear and sweet; stopt the phial well, and removed it to a cool place; the mixture tasted a little of the gall.	Motion stopt.	This mixture was sweet, with the fenugreek flavour.
and sweet.	Still in brisk fermentation, and sweet.	Removed the phial, and stopt it close; fermentation now almost over.	The mixture was now upon the turn; a little sourness just perceivable.

To face page 5.

M I X T U R E S.

End of 46 hours.	After 54 hours.	At the end of 4 days.
(1) Still at rest.	Still at rest.	A sourness now perceivable.
(2) Mild and sweet; much an top.	Brisk and sweet.	Fermentation appeared to be now very near over; liquor sweet both to the smell and taste.
(3) Menting; the liquor and sweet; refresh the bit of mutton of it up to dry, perfectly sweet.	Motion stopt; the bit of mutton dried and sweet.	Distilled this mixture; an almost insipid phlegm, with rather a vinous, than an acid taste, was the produce.
(4) Fermentation appeared almost over; liquor clear and sweet; add this and the spirit of lemon-juice, cool place, and close them; to the mutton.	Motion stopt; the bit of mutton dried and sweet.	The smell of this mixture, before distillation, was a little inclinable to the cheesy, and the phlegm obtained by distillation had a small degree of pungency, with the same rancid flavour.
(5) Clear and sweet; taste phial well, and wait it to a cool ere the mixture taste of the gall.	Motion stopt.	This mixture was sweet, with the fenugreek flavour.
(6) Fermentation brisk fermenta- tion sweet.	Removed the phial, and stopt it close; fermentation now almost over.	The mixture was now upon the turn; a little sourness just perceivable.

To face page 5.

tive mixture, with two drachms of fresh lemon juice.

4. Four ounces of the simple mixture, beat up with an ounce of spinage.

5. Four ounces of the simple mixture, with an ounce of green water-creffes.

6. Four ounces of the simple mixture, with two drachms of a very fetid liquor that lay about putrid mutton.

THESE mixtures, being put into phials not closely stopped, were all placed in a moderate degree of heat *, on the top of a sand furnace, wherein a retort was at work, on a process which required a continual fire for three or four days.

IN order to have a synoptical view of the progress from time to time, I formed the annexed table, No. I. wherein I minuted down the several appearances, exactly as they shewed at each examination; but the general progress of the five mixtures that fermented was as follows:

IN three or four hours the intestine motion was evident; and soon after all the solid part of the mixtures rose to the top;

* The degree of heat in this, and in all the other experiments of the like sort, was (as near as could be adjusted) that of the human body.

bubbles of air, and a thick scum, formed on the surface; a vapour, with some degree of pungency, and which extinguished fire, now began to discharge itself, and the peculiar smell of the several ingredients having gradually gone off, a sweetish kind of flavour, in some of the mixtures not unlike that of fenugreek seed, succeeded to it; while the motion becoming very brisk, little pieces of the solid matter every moment fell to the bottom of the phials.

THIS intestine motion continued for the periods expressed in the table; and by the time that it had ceased, the mixtures were clear, great share of what formerly floated having now fallen down; they were also perfectly sweet, and such of them as were committed to distillation, sent over a water, or phlegm, with a slight degree of pungency, and of the same sweetish smell of the mixtures, excepting one, that had a little of the rancid, or cheesy flavour.

THUS we see that the appearances, during the time that these mixtures were fermenting, are like those which attend the working of the sweet vegetable liquors; and, if fermented together in large quantities,

tities, such mixtures certainly would produce a liquor of an intoxicating quality.

For travellers of good credit assure us, that there are among the great variety of *Tartar* tribes inhabiting the wilds of *Siberia*, some who have methods of obtaining an intoxicating liquor from milk, which is brought to ferment by the admixture of some putrid animal substance; which Sir *John Pringle* finds (and the same thing may be seen in the foregoing table, at No. 6) to encrease very powerfully the tendency to fermentation, either in milk, or in the common fermentative mixtures. And others of these northern nations, make themselves drunk with an extraordinary sort of liquor, (which, we may well imagine, is none of the most palatable) made by allowing fish and water to ferment in holes dug in the earth, and lined with the bark of the birch-tree.

HENCE then it appears, that mixtures of animal and vegetable substances run regularly through the *three* stages of fermentation, termed by the chemists, the *vinous*, *acetous*, and *putrefactive*: but as the terms *vinous* and *acetous* can, with strict propriety, be applied to the fermentation of the

sweet vegetable liquors only, it will be more clear and comprehensive, to denominate the *three* stages of fermentation, either simply, *first*, *second*, and *third*; or, if it be more agreeable, *sweet*, *sour*, and *putrid*; and characterise them by their several products: The *first* or *sweet* stage, as yielding a sweet*, agreeably pungent, *inebriating* liquor, which being distilled, gives over an *ardent spirit*. The *second*, or *sour* stage, as turning the subject manifestly sour, and yielding an acid phlegm upon distillation. And the *third*, or *putrid*, when the texture of the substance fermented is fairly destroyed, and having lost its original characters of taste, colour, and

* *Sweet*, as opposed to *sour* and *putrid*. In the former edition, this matter concerning the drinks of the Tartar nations, was mentioned as a thing not yet sufficiently proved, and therefore it was proposed, to consider the sweet stage of fermentation as being two-fold; yielding, in the first instance, a sweet agreeably pungent, *inebriating* liquor, which being distilled, gives Alcohol; and in the second, a sweet liquor which is not *inebriating*, and only a sweetish phlegm on distillation: But, on inquiry, it is found, that the kinds of drink above-mentioned, really are in use among those people; and that these liquors, when distilled, yield an Ardent Spirit: therefore, the division proposed was unnecessary.

small

smell, it becomes fetid, rotten, and offensive; and, if committed to distillation, yields neither an inflammable spirit, nor an acid; but a sharp pungent liquor, being a solution of volatile alkaline salt, nearly similar to that salt which may be obtained, by the force of violent heat, from animal substances, without suffering them first to become putrid*.

THE reader, upon looking into the table, will find that there were two little bits of putrid mutton put into two of the phials, while the mixtures were fermenting; and that these bits of flesh were ren-

* When it is said, that a volatile alkali may be obtained from putrid substances by distillation, it is to be remarked, that whoever makes the experiment, must not suffer such substances to remain too long before they are distilled, unless kept in close vessels; because the volatile alkali, which is the offspring of putrefaction, is dissipated as fast as it is generated, inasmuch that, at length, nothing is left behind but an insipid water, or a solid matter, being an earth similar to common mould.

And it is in this way, that stinking water, after some time, becomes sweet; the volatile alkali, generated by the putrefaction of the animal and vegetable substances at first contained in the water, being, after a while, entirely dissipated, leaves the remainder without any disagreeable smell.

dered

dered sweet. This was owing to the action of the vapour, set free during the fermentation; and, as will be shewn at large in another place, the vapour from the sweet vegetable liquors produceth the very same effect.

It was found, that the vapour from the mixtures agreed likewise in another circumstance with the *Subtile Gas*, as it was termed by the old chemists, namely, that of extinguishing fire; and, I dare say, it would also suffocate animals. But notwithstanding that this vapour, if applied in large quantity to the lungs, might prove so very pernicious, yet it does not by any means follow, that it must necessarily produce the same deadly effect, if pent up in the bowels: we may be very certain that it does not; for if that were to be the case, people would be in very great danger after almost every meal they eat, since it is evident, that the vegetables most commonly used as a part of our food, when mixed, either with flesh, or with the native animal juices, actually do raise a fermentation in the first passages, which must of course produce a great deal of this active vapour.

THERE

ALIMENTARY MIXTURES. 11

THERE is not sufficient ground therefore, for acquiescing in a theory which hath sometimes been taught, attributing the sudden death of people who had eaten largely of fruit, or the like, to the action of this subtile spirit, as supposing it to benumb and deprive the nerves of all power and influence.

IF this hypothesis were not ill founded, persons in these circumstances, who have been rescued from death by the timely exhibition of an emetic, would not recover themselves so immediately as they are known to do; which shews that the distress must have been occasioned merely by the over distension of the stomach; for had the pernicious vapour once fairly made its deadly impression, emptying the stomach would avail but little; and, if the party recovered at all, it would be but slowly, and not without much consequent relaxation, and weakness of the paralytic kind*.

THEREFORE, instead of imagining this active and subtile vapour to be productive of any harm in the body, it will appear

* Vide *Boerhavii Elementa Chemicæ*, tom. ii. p. 180 & 181.

hereafter,

hereafter, that there are very strong reasons for believing, that it is the *grand preserver* of animal fluids from *putrefaction*; that it attempers acrimony, is a *principal agent* in *nutrition*, and, perhaps, contributes somewhat to animal heat.

SINCE things of such different natures as bread, lemon-juice, spinage, and water-creffes, all run with equal facility into fermentation, we might almost venture to conclude that any vegetable, when mixed with an animal substance, and furnished with the requisite quantity of water, will likewise ferment. But to try this matter still farther, in a few days after going through the foregoing experiment, I mixed up no less than twenty-one of this kind of mixtures, most of them being in quantity about four ounces, *viz.*

1. Bread and water.
2. The same, with two drachms of saliva.
3. Bread and water, with green herbs.
4. The same, with two drachms of saliva.
5. Flour and water.
6. The same, with two drachms of saliva.

7. Green

7. Green herbs and water.
8. The same, with two drachms of saliva.
9. Flour and water, with green herbs. (The green herbs were spinage, water-creffes, and onions, equal parts, beat up together.)
10. The simple fermentative mixture: (i. e. Flesh meat, bread and water.)
11. Flour and flesh meat, with water.
12. The simple mixture, with about an ounce of green water-creffes.
13. The simple mixture, with an ounce of spinage.
14. The simple mixture, with an ounce of green onions.
15. The simple mixture, six ounces; lemon-juice, one ounce.
16. The simple mixture, six ounces; fresh wort, one ounce.
17. The simple mixture, six ounces; strong solution of sugar, one ounce.
18. The simple mixture, six ounces; strong solution of honey, one ounce.
19. The simple mixture, six ounces; vinegar, one ounce.
20. The simple mixture, six ounces; brandy, one ounce.

14 On the FERMENTATION of

21. A simple fermentative mixture, made with salt beef.

THESE mixtures were all made up at night, and lay fourteen hours before they were placed in a sand bath, where it was intended to have kept up a moderate degree of heat.

THEY were all placed in the sand at ten o'clock in the morning, being then, every one of them, perfectly sweet.—The fire was now ordered to be kindled: In six hours I went to see how things were going on, and was greatly vexed and disappointed to find that the fire, through inattention of the servant entrusted with the care of it, had been made so strong that the mixtures were all in a much fairer way to boil than to ferment. I therefore removed the phials from the sand, and reckoned all this as so much lost labour, not expecting, after having been so much over-heated, that they would ferment at all. However, in six hours more, I again visited them, and finding some of the mixtures in motion, I marked down the several appearances, exactly opposite to each, as may be seen by looking into the second table, and first column.

BUT

BUT as I imagined that the natural course of the fermentation must have been disturbed from the first setting out, on account of the extraordinary heat, I was not very solicitous about a minute and accurate observation of the progress; more especially as I intended to take the trouble of mixing up an entirely new set. I therefore did not go near the place where the phials stood for two days, leaving them all this while in the cold; but going then to examine them, was surprized to find that notwithstanding their being unassisted by heat, yet most of them had fermented, and some of them were still in motion. I therefore minuted down, in the table, the appearances particularly belonging to each, as they stand in the second column.

SOON after this time, I engaged in a course of experiments, with a view of discovering the relative quality of air, set free from different compounds, and therefore found it unnecessary to repeat all the experiments of the second table, as I had once intended; but at the end of a fortnight I went to the Elaboratory, where the phials had been left, and found some of them sour, some putrid, others musty, and

and some of the mixtures still sweet ; but as I had not the table with me, did not minute them down particularly.

Now since it appears, that these mixtures ferment so very readily, even when unassisted by heat, how can there be any doubt but they must run through the same process when they are received into the warm stomach, and are put in motion by the fermentative power of the saliva ? which not only the authorities of *Hoffman* and *Boerhaave*, but likewise the experiments just now recited, shew to be possessed of this power in a very eminent degree ; as may be plainly seen by comparing the numbers 1, 3, 5, and 7, of the second table, with the mixtures numbered 2, 4, 6, and 8, in the same table.

ON this presumption the progress of digestion in the human body may be traced in the following manner.

THE food, divided by *mastication*, and mixed with the *saliva*, is fitted for beginning the *intestine motion* very soon after the alimentary substances are received into the stomach ; this motion being raised by the temperate warmth of the place, perhaps by the remains of the former meal, but
more

Table II. Of A L

MIXTURES of	
(1) Bread and water.	No signs of
(2) The same, with about 3ij of saliva.	No sign at
(3) Bread and water, with some green herbs.	No sign.
(4) The same, with 3ij of saliva.	Motion enu-
(5) Flour and water.	No sign
(6) The same, with 3ij of saliva.	No sign like
(7) Green herbs and water.	No sign.
(8) The same, with 3ij of saliva.	Motion feet,
(9) Boiled mutton, with some green herbs.	No sign now risen
(10) Bread and boiled mutton, with water.	Motion feet,
(11) Flour and boiled mutton, with water.	Motion
(12) Bread and mutton, with water-creffes.	Motion begins herb not smell
(13) The same, with spinage.	Motion begins herb not are-
(14) The same, with green onions.	Motion fair of the onion
(15) The same, with juice of lemons.	No me ;
(16) The same, with fresh wort.	Motion of
(17) The same, with sugar and water.	Motion begins as the prey
(18) The same, with honey and water.	Motion begins in the mix
(19) The same, with vinegar.	N
(20) The same, with brandy.	N
(21) Salt beef and bread, with water.	N and ke

Table II. Of ALIMENTS

MIXTURES of	I.
(1) Bread and water.	No signs of intestine motion.
(2) The same, with about 3ij of saliva.	No signs of motion.
(3) Bread and water, with some green herbs.	No signs of motion.
(4) The same, with 3ij of saliva.	Motion fairly begun.
(5) Flour and water.	No signs of motion.
(6) The same, with 3ij of saliva.	No signs of motion.
(7) Green herbs and water.	No signs of motion.
(8) The same, with 3ij of saliva.	Motion beginning.
(9) Boiled mutton, with some green herbs.	No signs of motion.
(10) Bread and boiled mutton, with water.	Motion just perceivable.
(11) Flour and boiled mutton, with water.	Motion fairly begun.
(12) Bread and mutton, with water-creffes.	Motion begun; smell of herb not perceivable.
(13) The same, with spinage.	Motion begun; smell of herb not perceivable.
(14) The same, with green onions.	Motion fairly begun; smell of the onion yet strong.
(15) The same, with juice of lemons.	No motion begun.
(16) The same, with fresh wort.	Motion fairly begun.
(17) The same, with sugar and water.	Motion begun; not so brisk as the preceding.
(18) The same, with honey and water.	Motion begun, and as strong in the mixture with the water.
(19) The same, with vinegar.	No motion.
(20) The same, with brandy.	No motion.
(21) Salt beef and bread, with water.	No motion.

MENTARY MIXTURES.

	2.
ffine motion.	Appears not to have stirred at all ; four.
motion.	Appears to have fermented, there being froth at top ; now at rest, and quite sweet.
motion.	Had <i>not</i> stirred ; smell of the herbs strong.
y begun.	Had fermented ; now at rest ; sweet, of the fenugreek smell.
motion.	Had <i>not</i> stirred ; nor four.
motion.	Had fermented ; now at rest ; smell sweet, like the fenugreek.
motion.	Had not stirred ; smell of the herbs strong.
ginning.	Had fermented ; scum on the surface ; smell sweet, like the fenugreek.
motion.	Had undergone the fermenting motion, tho' now at rest, the mutton and herbs having all risen to the surface.
perceivable.	Still in motion ; great scum at top ; smell sweet, like the fenugreek.
y begun.	Still at work ; the smell perfectly sweet.
smell of the ivable.	Had wrought briskly ; now on the decline ; smell of the fenugreek strong.
smell of the ivable.	Still at work ; smell sweet, exactly like the preceding.
gun ; smell of strong.	Did not appear to have wrought much ; smell of the onion still strong.
begun.	Had fermented ; smell of the lemon entirely gone ; mixture sweet.
ly begun.	Not yet quite at rest ; sweet ; peculiar smell of the wort now lost.
not so brisk g.	At rest ; fourish, with a little of the cheesey smell.
nd as strong as with the wort.	Mixture sweet, and at rest ; appears to have wrought pretty briskly.
tion.	Does not appear to have stirred.
tion.	Does not appear to have stirred.
tion.	Appears to have wrought, the lighter parts, and much scum, being on the surface ; sweet, like the mixture with the fresh meat.

more certainly by the fermentative power of the *saliva* and *gastric juice*. The first effect of this motion, is to throw up, to the surface, the solid part * of the alimentary mixture; which soon again subsiding, the air that buoyed up the solid particles having escaped, the union of these is presently destroyed, and the whole mixed with the digestive fluids; this intimate mixture being much assisted and completed, by the agitation caused by the peristaltic motion, by the alternate pressure of the diaphragm and muscles of the abdomen, and by the continual pulsation of the neighbouring large blood vessels.

Thus the aliment passeth on from the *stomach* into the *duodenum*, and through the long tract of the *smaller intestines*; where having its original nature entirely

* Every person must have perceived, at one time or other, that after a hearty meal, if an eructation should by any means be excited, some of the solid part of what had been taken into the stomach comes back towards the mouth. If the meal consisted of a mixture of animal and vegetable food, it is part of the vegetable that always rises; which corresponds exactly with the appearances in the phials, where I constantly observed the vegetable part of the mixture to rise first.

C

changed,

changed, by the admixture of the *bile* and *pancreatic* juice, but *chiefly* by the fermenting motion, which still continues going on, the several kinds of food are all blended, and mixed together into one mild, sweet, and whitish liquor, now in brisk fermentation, called *chyle*. This *chyle*, * so compounded, is taken up by millions of little absorbent vessels, fully charged with the subtil, active, antiseptic spirit, and conveyed to the *receptacle*, where, and in the *thoracic duct*, it is further mixed with

* That the chyle is a liquor in a state of actual fermentation may be proved by observing the changes that happen in milk, which is nothing but chyle, a very little anamalized. " The acidity which milk naturally contracts in a few days, must be considered as the effect of a fermenting motion which discovers in that liquor an acid that was not perceptible before; this, properly speaking, being an acetous fermentation, which the milk passeth through in its way to putrefaction, which soon follows if it be exposed to a hot air." *Macquer*.

Hence the reason why a diet consisting entirely of milk is so apt to create a sourness in the first passages; for being in actual fermentation when taken into the body, if it be not very soon carried through the smaller intestines, the second stage will come on. And here we may perceive the necessity that there is for the tossing and exercise of infants at the breast.

great

great quantities of *lymph*, and after no very long course, is poured into one of the large veins in order to communicate its intestine motion to the blood, to prevent the natural tendency of the fluids to putrefaction, and to repair the waste which our bodies, every moment of our lives, must necessarily sustain.

THE gross, insoluble, and fecal parts of the aliment being thrown off from such as were finer and more nutritious, pass on to the larger intestines; where, at their very first entrance, they meet with a store of sour and putrid ferments, lodged in the *cæcum*, which, in a very short time, convert the alimentary remains into their own nature; and thus communicate a degree of sharpness which must soon stimulate the intestines to a contraction, that ends in expelling these useless and offensive matters out of the body.

ALL this is to be understood of the digestive process, as carried on in persons who have the happiness to enjoy a perfectly sound state of health; but in valetudinary people, of weak and relaxed habits; in pregnant women, whose stomachs, and a great share of the smaller intestines, are

thrust out of their natural situations ; and in people whose inclinations or professions oblige them to lead sedentary lives : the food is often detained so long in the first passages, as to pass on to the *second* stage of alimentary fermentation : and then it produceth a most austere acid, which however is exactly in the same state with a foreign acid, for the lacteals will admit none of it : It is therefore of necessity accumulated, and proves the cause of sour eructations, heart-burning, vomiting, griping, or looseness, according to its quantity, degree of strength, and place where lodged.

THIS sour acrimony, when once established, is not to be removed without some difficulty ; for some of it always lying in the first passages, serves as a leaven to act on every thing taken into the stomach ; and thus, hurrying the alimentary mixture through the first stage, and immediately bringing on the second, renders the food incapable of furnishing a nutritious chyle, as not being thoroughly changed and fermented, which plainly appears, from the paleness, and languid disposition of those people who are much afflicted with a sourness in the stomach. And hence one reason,

son, why exercise, especially riding (which agitates the viscera, and prevents the too long stay of the aliment in the first passages) and the aromatic gums and bitters, together with chalybeates, (which produce the same effect, by their stimulating and strengthening qualities) prove so very serviceable in all these cases.

BUT if the aliment, either from its own very putrescent nature, or from its too long stay within the confines of the smaller intestines, should ever proceed on to the third stage of fermentation, it will then become so offensive as to occasion immediate efforts to throw it off, if the quantity of putrid matter be in any degree considerable; but if that should not be the case, it may then remain in the body, and gradually insinuate itself into the mass of fluids, until it accumulates to such a height as to throw the whole system into a confusion, which must terminate either in the concoction and expulsion of the offending matter, or in the destruction of life: For any thing putrid is totally incompatible with the perfect well being of an animal body; and therefore *Putrefaction* cannot by any means be admitted to a share in the

22 On the FERMENTATION, &c.

process which is to furnish this body with nourishment and support.

THE spirit, or vapour, which is set free from the mixtures during their fermentation in the first passages, which enters the composition of the *chyle*, and with that fluid is transmitted to the *blood*, appears to be chiefly the *Fixed Air* of the alimentary substances ; but as this matter cannot be fully explained, nor thoroughly understood, without a knowledge of the properties of *air*, when considered as a constituent principle of bodies, I must reserve the further illustration until it be shewn what those properties are.

ESSAY

ESSAY II.

ON THE
NATURE and PROPERTIES

OF

FIXED AIR.

*May we not, with good reason, adopt this
now fixed, now volatile Proteus, among
the chemical principles, and that a very
active one?*

HALES.

ESSAY II.

ON THE

NATURE and PROPERTIES of FIXED AIR,

THAT great improver of natural knowledge, the honourable Mr. Boyle, knew from a variety of experiments, "that air might be produced by the fermentation, corrosion, and dissolution of bodies; by the boiling of water, and other liquors; by the mutual actions of bodies upon one another, especially the saline ones; and, lastly, by the analysing and resolving certain substances;"* but this noble philosopher seems not to have known the principal use of this air, which is so intimately mixed with, and

* Boyle's Works, abridged by Shaw, vol. iii. p. 21,

wrought

wrought into the composition of animal, vegetable, and mineral bodies.

It is therefore to the indefatigable industry of the excellent Dr. *Hales*, that the world is indebted for the discovery that this elastic matter, so nearly resembling common air, is the *principle* which forms the *cement*, or *bond of union*, between the several constituent particles.

BUT although it is now near forty years since this truly useful philosopher published the account of his curious experiments, and thereby opened a new field in natural philosophy, yet the enquiry hath been but little prosecuted; and, excepting the Baron de *Haller*, there is no systematic writer that I know of, either in chemistry or physiology, who has given that attention to Dr. *Hales's* discoveries which they certainly merit.

THIS celebrated physiologist indeed hath fully adopted the system of *Hales*, and holds air to be the *vinculum elementorum primarium*, the *true cement* which binds together the earthy particles of bodies*.

ALL

* Videtur aer vinculum elementorum primarium constituere, cum non prius ea elementa a se invicem disce-

dant

ALL the other writers seem either not to know, or not to believe any thing of this theory; since some of them make *Phlogiston* the bond of union, others look on *water* as the *cementing principle*, and some ascribe cohesion solely to the attraction subsisting between the particles of elementary *earth*.

AND it is this last opinion which is embraced by the learned *Gaubius* *; but it

dant quam aer expulsus fuerit. *Halleri Elem. Physiologiae*, tom. i. in capite primo.

Aeris dotes (*in sanguine scil.*) nondum satis notæ sunt.—Id interim certum est, ad *Gluten* pertinere, quo omnium firmorum in universa *Natura Corporum* elementa cohærent, ut omnino, neque fere metallum, neque os, neque lapis, neque testa, neque *Sal* dissolvatur quin aer extricatus prodeat. *Ejusdem*, tom. ii. p. 155.

* In sicca materie terreum præ aliis cohærentissimum est, atomorum suarum in proximos contactus compactione duritiem daturum vix edomandam nisi aliorum interventu molliretur. Hoc principium cohesionis quietis, inertiae. Et ipsa glutina, terræ quam continent suam cohærentiam debent. *Gaubii Instit. Patholog. Med.* sect. 142 & 143.

But insinglafs, and other substances of the like nature, are deprived of the glutinous quality by quicklime; the reason of which will be laid before the reader in the course of these essays, particularly the fifth.

did

did not occur to this very celebrated professor, that if *earth* were the *only* cause of *cohesion* in bodies, there never could be any *change* in their *combination*: For “if all
 “the parts of matter were only endued
 “with a strongly attracting power, whole
 “nature would then immediately become
 “one unactive, cohering lump; where-
 “fore it was absolutely necessary, in or-
 “der to the actuating and enlivening this
 “vast mass of attracting matter, that there
 “should be every where intermixed with
 “it a due proportion of strongly repelling
 “elastic particles, which might enliven
 “the whole mass by the incessant action
 “between them and the attracting parti-
 “cles *.”

Now the distinguishing property of the earthy-principle is, that it resists the action of fire, and remains behind the rest, after they are all raised or dissipated: But it is plain, that the principle upon which cohesion *immediately* depends, is of a *volatile* or *fugitive* nature, not *fixed* and *inert*, like earth; otherwise, the face of this globe would be covered with *dead* bodies; for

* Hales's Staticks, vol. i. p. 314.

when

when once a stop is put to the life of either animal or vegetable, they become no longer useful in the general system, as organized bodies; and it is then absolutely necessary that their frame should be dissolved, and their elementary particles dispersed, in order to form nourishment for those beings that yet continue to live.

It will appear hereafter, that the opinions of *Hales* and *Haller* are well grounded; and that the *principle* which is generally known by the name of *Fixed Air*, is the *immediate* cause of cohesion, since the preservation of firmness and soundness in bodies depends on restraining the escape of this *air*; for the moment it *flies off*, and *resumes its elasticity*, we shall see that the other constituent particles, the *earthy*, the *saline*, the *oily* or *inflammable*, and the *aqueous*, being thereby put in motion, immediately begin to exert their several peculiar attractive and repulsive powers, and run into *new combinations*, which first change, and at length altogether destroy, the texture of the substance they formerly composed, provided that this substance contained in itself a sufficient quantity of water to allow of the intestine motion,
by

by giving the proper degree of fluidity*; for without fluidity there can be no intestine motion, and without intestine motion there can be no change of combination; since we see that such animal and vegetable bodies as are suddenly deprived of their water, or naturally contain very little, are almost as durable and unchangeable in their textures as minerals.

THAT this *air*, which is alledged to be the *cementing principle*, should have the property of passing, from a *repellent elastic* state, to the opposite, of *non-elastic* and *strongly attracting*, and *vice versa*, is not easily comprehended; nor indeed could it be believed, if the number of experiments, which prove it, had not put the matter beyond all manner of doubt: So that the fact is as certain as that we breathe air†.

THIS, as well as the property of *elective attraction* in the minute particles of matter, was not unknown to that amazingly-

* Here, we are not to understand absolute fluidity, but only such a degree of moisture and softness as will allow the several constituent particles to shift and change their places.

† See Hales's *Statics*, vol. i. p. 293, and vol. ii. p. 279 & 281.

comprehensive genius, Sir *Isaac Newton* *, and it was by pursuing the hint of that great man, that Dr. *Hales* engaged in an enquiry which enabled him to establish the theory aforementioned, and which hath been illustrated and confirmed, with regard to a particular class of bodies, by the experiments of Dr. *Black* †.

BUT there is still a great deal wanting to complete the illustration, which demands a number of accurate experiments; more, perhaps, than will suit the leisure or inclinations of any one person, and therefore must be brought to perfection by the united labours of many.

WITH this view, I began a set of experiments, and resolved to observe carefully the appearances attending the fermentation of such mixtures as usually make up part of our food, and also the appearances which attend the putrefaction of animal substances; hoping from this branch of enquiry to obtain further light concerning some points of very great importance in the animal œconomy.

* See Newton's Optics, quest. 30 & 31.

† In his experiments on *Magnesia*.

E X P E R I M E N T I.

To try the relative quantity of air, set free from different mixtures by fermentation, I put into three phials, marked 1, 2, and 3, first the simple fermentative mixture, about three ounces; secondly, a like quantity of bread and water; and the third phial had nothing but three ounces of common water; these two last being designed as standards.

THE phials, as represented at B (fig. 1.) were placed in a tin pan (A) half full of water, on little pedestals, and covered over with cylindrical glasses (C) of seven inches in height, and three in diameter.

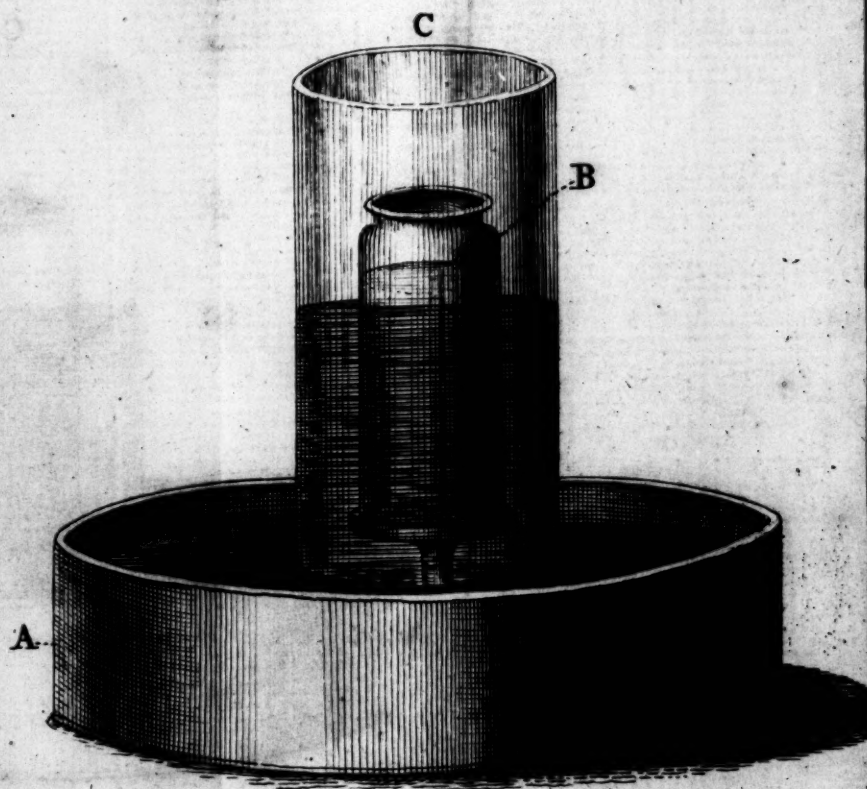
THE air was then drawn out of the cylindrical glasses, by suction through a syphon, so as to raise up the water about half way, and then little bits of paper were pasted on the sides, to mark the rise of the water.

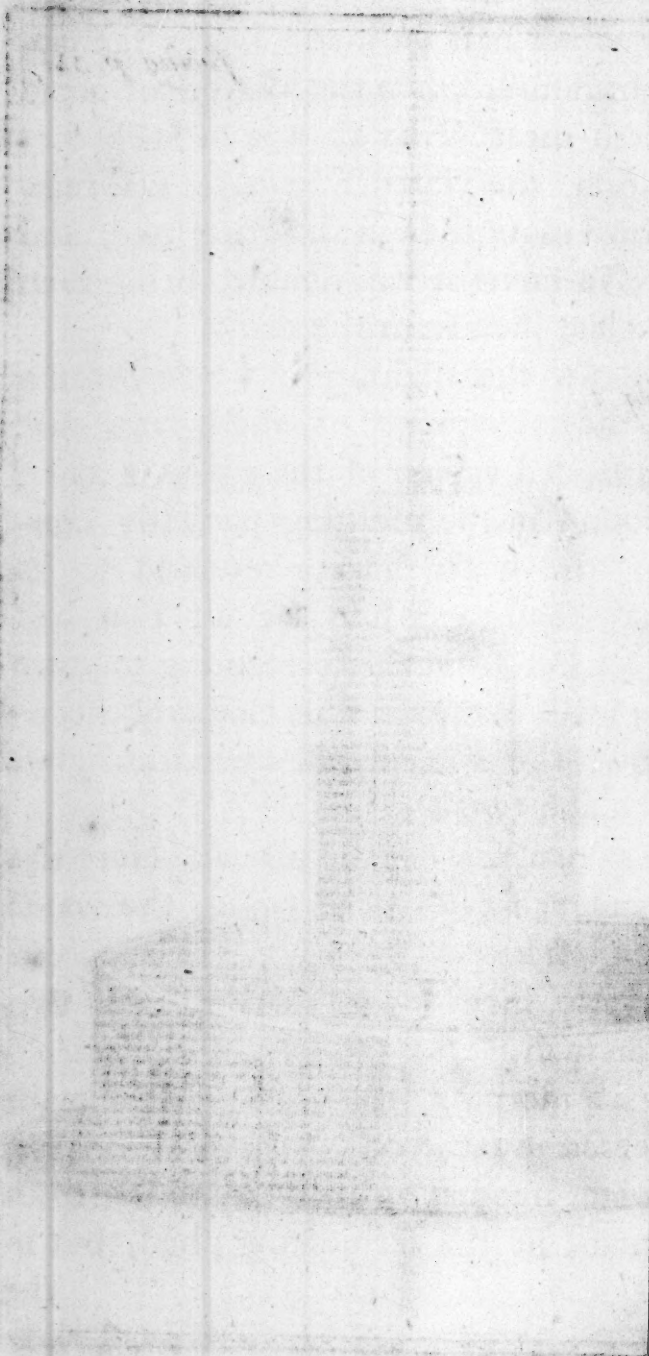
EVERY thing being thus ordered, the whole apparatus was placed before a fire, at such a distance as was sufficient to keep up a moderate degree of heat.

As the heat began to operate, the vapour in each of the glasses expanded itself, and forced

facing p. 32.

Fig. 1.





forced down the water to a certain depth, nearly about half an inch; but at the end of eight hours, when the mixture of bread and flesh-meat (No. 1) was in brisk fermentation, the water in its cover was sunk one-third more than in the other two, and in twelve hours it was double, being then a complete inch from the mark.

DURING the night, the whole became cool; the consequence of which was, that the expanded vapour of the glasses 2 and 3 was found in the morning perfectly condensed, the water having returned to its original height; while the air that had been set free from the fermenting mixture (No. 1) still maintained its elasticity, keeping down the water in the cylindrical glass an inch and two-tenths.

THE pan was again placed before the fire, and at six in the evening, the water in the glass belonging to No. 1. was forced down two inches, that in the other two half an inch.

NEXT morning, the vapour being again condensed by the cold during the night, the water stood at an inch and a half from the mark in the fermenting phial, but in

D

the

the phials No. 2 and 3, it rose to the marks as before.

I placed the whole again near the fire, and the vapour operated as before. On the third morning, the water belonging to the phial No. 2 had returned as usual to the original height; while in the other, No. 1, it was still kept down a full inch and half, by the force of the extricated air.

I now threw out the bread and water (from No. 2) and put into the same phial half an ounce of boiled beef cut small, and two ounces of water; and having placed it under the cover, and raised the water by suction, as before, I set it in the pan along with the fermented mixture, which by this time had entirely ceased from working. After standing six hours in the warmth, no elastic air appeared to have been set free from the beef, the water being sunk only half an inch. The other phial (No. 1) now stood exactly at an inch and a half, which, allowing half an inch for the expansion of the vapour, shewed that the mixture had now been for some time in a condition to absorb air, as Dr. *Hales* termed it, for at the same hour on the day before the water was down two inches.

ON

ON the fourth morning, when all was cool, the fermented mixture was found still to keep down the water near an inch, but in the glass with the beef only the water was up to the mark.

FROM hence, and from other experiments*, it should seem, that animal substances when alone, and the substance of vegetables when alone, do not part with their air without some reluctance; but that when the two are mixed together, under certain conditions, that then an attraction begins, which presently throws off the air that so closely adhered to each of them in a separate state; and this air, in the moment of its extrication, resuming its elasticity, destroys the union of the minute particles, and, producing an intestine motion, totally changes the nature of the body in which it was fixed, by allowing a new disposition, and a different combination, to take place.

IT has appeared that the alimentary mixtures, though at first they throw off a

* See No. 1 of the first table; and No. 1, 3, 5, and 7, of the second table; and compare them with those mixtures that had either flesh or saliva.

considerable quantity of elastic air, yet after some time, they *absorb* this air, and again reduce it to a *non-elastic* state.

As the fermentation in the stomach must begin very soon after the aliment is received into it, we may reasonably conclude, that the alimentary mixture will also begin to *absorb* much sooner in the bowels than it appeared to do in the phial; and thus the elastic air, which is set free from the food, will, in great measure, return to a fixed, or non-elastic state, before the chyle enters the lacteals *.

* “ Since we find such great quantities of elastic air
 “ generated in the solution of animal and vegetable
 “ substances, it must needs be, that a good deal does
 “ constantly arise from the dissolving of the aliments
 “ in the stomach and bowels, which dissolution it greatly
 “ promotes; some of which may, very probably, be
 “ reformed again by the fumes which arise with
 “ them.— Thus we see, that the variety of mixtures
 “ in the stomach appear sometimes to generate, and
 “ sometimes to absorb air. In a true kindly digestion,
 “ the generating power exceeds the absorbing power
 “ but a little; but whenever the digestion deviates in
 “ some degree from this natural state, to generate a
 “ greater proportion of elastic air, then are we troubled
 “ more or less with distending flatulences,” *Hales's Stat.*
 vol. i. p. 309.

It has been imagined by a very ingenious gentleman *, that the alimentary substances carried their fixed air into the blood, without its ever having been extricated, or thrown off into an elastic state, during digestion; but this is to suppose, that these substances are never thoroughly broken, nor suffer any change of combination, from the action of the digestive organs, a supposition which cannot by any means be allowed; it being *demonstrable* (as I humbly apprehend) that the food is intirely broken, and its original nature totally changed, while it is passing through the alimentary canal.

EXPERIMENT 2.

INTO the same three phials which were made use of in the foregoing experiment I put, first, the simple fermentative mixture; 2, the same, with one-third fresh

* Dr. Black. In his *Dissertatio Med. Inaug. de Humore acido a Cibis orto*, he is so far from believing that the aliment naturally ferments in the stomach, that he looks on such fermentation, when it does happen, to be the cause of many, and those very dangerous diseases. See p. 8 and 9 of the *Thesis* above-mentioned.

lemon-juice ; 3, the same, with one-third claret.

THE phials were all placed in the pan as before, and the water drawn out by suction. The phial, No. 1, presently began the motion, the solid part all rising to the top ; and as it fermented, I found that more air was extricated than there had been from No. 1, of the preceding experiment, which I ascribed to the tenderness of the mutton which was used in this present mixture, as having been longer kept than some beef that I had mixed up for the former trial.

No. 3, with the claret, did not begin to move until it had stood 24 hours ; and No. 2, with the lemon-juice, after remaining thirty-six hours, shewed no signs of motion at all ; so that here the proportion of lemon-juice was too great ; and it appears to have acted as a pure acid, which, as well as fermented liquors, is found to restrain the alimentary fermentation.

EXPERIMENT 3.

At the end of thirty-six hours, I threw out these mixtures, and filled the phials again, with, 1, the simple fermentative mixture,

mixture, and an ounce of green herbs; (*viz.* onions, water-creffes, and garden-creffes, *aa p. æ.*) 2. The fermentative mixture, with an ounce of lemon-juice and half an ounce of *saliva*; 3. The mixture, with two drachms of very strong rum.

THE mixture, No. 2, with the lemon-juice and *saliva*, began to ferment immediately; and, before two hours were expired, all the solid ingredients had risen; No. 1 began soon after; but it was not till after ten hours, that the mixture with the rum shewed any signs of motion.

HERE we have another strong instance of the fermentative power of the *saliva*, which being compared with those in the second table, plainly shew that *Boerhaave* and *Hoffman* were both in the right, when they ascribed this quality to that fluid.

WHEN the mixture with the lemon-juice had ceased from working, I dropt *Lixivium Tartari* into some of the liquor, but not the least ebullition ensued, which shews, how entirely the fermenting motion changes the nature of the substance fermented; for here was one-third of this mixture, a sharp acid liquor, which would have effervesced violently before the fer-

mentation began; and hence we may conclude, that acids, even independant of their mixture and dilution by the native animal juices, must be neutralized by the mere force of fermentation in the first passages, if the digestion proceeds as it ought to do.

IN the mixture with the herbs, the smell of the onion was still very strong, even after the fermentation was over; which agrees with what every body must have perceived with regard to the fermentation of things of this sort in the stomach; some of this tribe, such as garlick, retain their peculiar smell, even after they have undergone so much of the action of the body, as to become perspirable matter.

ALTHOUGH the mixture with the rum was the latest in beginning, yet, after the motion began, it was more brisk, and finished its career sooner, than either of the other two phials; but not above half the quantity of air was extricated that there was from the simple mixture, No. 1, of the foregoing experiment.

EX-

EXPERIMENT 4.

Two of the phials were placed in the pan, and covered with the glasses; one having two ounces of a caudle, made of oaten gruel, Lisbon white-wine, and sugar, with a little lemon-juice; and the other, the same quantity of the caudle, and two drachms of *saliva*.

THE phial which had the *saliva*, began the fermenting motion immediately, but it never became brisk, and in about 14 hours intirely ceased; a small quantity of air was extricated at first, but the mixture soon went on to the absorbent state, for by the time that the fermentation had ceased, the water in the cylindrical glass was raised half an inch *above* the mark.

THE other phial without the *saliva* never shewed any signs of motion.

EXPERIMENT 5.

I filled the three phials, 1, with juice of turnips alone; 2, the same juice, with two drachms of *saliva*; and, 3, bread and water, with two drachms of *saliva*, and as much spirit of vitriol as gave the mixture a considerable degree of sharpness, and made it effervesce smartly upon dropping in *oil of tartar*.

THE

THE phial, No. 2, with the *saliva*, began to shew signs of motion immediately; and, in five or six hours the simple turnip juice was likewise in motion, and both the one and the other fermented very briskly.

BUT No. 3, though it shewed signs of motion very early, never became brisk, so much had the acid destroyed the fermentative power of the *saliva*. However, what little motion it did undergo, so far altered the state of the acid, that it would not effervesce, upon adding the fixed alkali.

EXPERIMENT 6.

INTO one of the phials I put three ounces of the simple fermentative mixture, and a drachm of the *cortex* in powder; into the second phial I put the same quantity of the mixture, and a drachm of *caraway-seeds* in powder; the third had nothing but three ounces of the mixture, to serve as a standard to the other two.

THE phial with the *bark* began to shew signs of motion as soon as it became warm, and the other, with the seeds, in two hours after; the simple mixture was not in motion till three hours later.

THE *cortex* fermented very briskly, as did

did also the carraway-seeds; but there was at least one half more air extricated from the latter than from the former, which shews that many of the carminatives may generate air in the bowels as well as expel it: And if these things were given in large doses, we might account for their action, by saying, that it is the sudden extrication of the air which stimulates the muscular coat of the stomach, and enables it to throw off the offending flatus.

BUT as they are always given, and indeed can only be taken in small quantities, it is upon the hot oil with which these aromatic substances abound, that their carminative virtue depends: for we see that ardent spirits, which neither contain much air themselves*, nor facilitate the extrication thereof from any thing they are mixed with, are yet very powerful carminatives, which must therefore be owing solely to their power as stimulants.

EXPERIMENT 7.

I HAD, on a former occasion, made up mixtures with sugar, wort, and honey, but

* "I found very little air in 54 cubick inches of brandy." *Hales's Stat.* vol. i. p. 181.

as the progress of that experiment was interrupted, I resolved to repeat it.

THREE mixtures were made accordingly :

1. Of boiled mutton (without any bread) $\mathfrak{z}$ ss, water $\mathfrak{z}$ ij, and fresh wort, or infusion of malt, $\mathfrak{z}$ ij.

2. The same quantity of mutton and water, with two ounces of a strong solution of brown sugar (about four to one).

3. The like quantity of mutton and water, with two ounces of strong solution of honey.

THESE phials were not placed in the pan, as in the foregoing experiments, but stood in a sand bath, heated by a lamp.

THE mixture, No. 1, with the wort, was the first that began the fermenting motion, and that very early, in less than an hour after the phial became warm; the sugar began next, about two hours later; but the honey was not in motion until it had stood above eight hours.

I FREQUENTLY shook all these mixtures, and found the fermentation greatly accelerated thereby.

THUS it appears that honey is not so fermentable when mixed with animal substances,

PROPERTIES OF FIXED AIR.

stances, as sugar; nor sugar so prone to fermentation as the common infusion of malt; and perhaps those disturbances in the bowels, which are often observed in people of delicate and very irritable constitutions, after the use of honey, are occasioned by this refractory quality, since it may lie a considerable time undissolved in the stomach, and there act as a stimulating salt.

UPON the same principle, this may guide us in directing sugar and honey in the diet of sick persons: Where the nature of a disease requires a diet of the most easily fermentable kind, sugar must be preferable to honey; unless somewhat of a laxative nature be likewise demanded, when honey, unless the patient has a peculiar dislike to it, will have the advantage.

EXPERIMENT 8.

WHILE these mixtures were in fermentation, I suspended a little thin bit of very putrid mutton in the neck of the phial with the wort, and left it there during the night; in the morning it was found to have lost the putrid stench, having now no smell but that of the mixture.

EX-

E X P E R I M E N T 9.

I ALSO fixed one extremity of a bended glass tube into the neck of the phial with the sugar, and the other into a little bottle containing a drachm, or thereabouts, of the spirit of *sal ammoniac* made with *quick-lime* (as represented in the third figure). After they had remained in this situation twenty-four hours, I separated the phials, and dropping in spirit of vitriol on the volatile alkali, found it effervesce very smartly.

AFTERWARDS, I transferred the air from a simple fermenting mixture (*i. e.* bread, flesh meat, and water) into the same caustic volatile alkali; as I did likewise from melasses wash * in fermentation, and from a mixture of *cortex* and putrid bile, which fermented briskly, and sweetened the putrid gall, all with equal success; in every one of these instances the spirit of *sal ammoniac* effervescing very smartly, after

* Melasses wash, as it is termed by the distillers, is a liquor brewed from melasses and water, and afterwards fermented by the means of yeast; in order to distil, and make what are usually called sugar-house spirits.

having

having been supplied with air from the substances in fermentation.

WHICH shews, that the air set free during the fermentatory process, although it resumes its elasticity immediately on being thrown off, is yet capable of returning instantly to a fixed state, provided it meets with any substance which hath the power to receive it.

BUT here I find that I have been proceeding rather too fast, unless the reader should happen to be perfectly well acquainted with Dr. Black's very ingenious paper on the *magnesia*: if he is, I shall be understood; if not, I shall appear to have talked in a language altogether unintelligible.

IT is sufficiently known, that the *volatile alkaline spirits*, when made by the admixture of *quick-lime* in the distillation (which they for the most part are, in order to render them more pungent) *do not effervesce* upon the addition of an acid; and that no salt, in a concrete form, ever rises when the process is carried on in this manner.

BUT it was never well understood what occasioned these peculiarities, until Dr. Black published his experiments.

FROM

FROM these it appears very plainly, that *calcareous earths* have a strong degree of *affinity* with *fixed air*, and in their natural state abound with it; that by *calcination* they are *deprived* of their *air*, and on account of this deprivation, acquire a high degree of *causticity*, and become *soluble* in water; and that, on the other hand, this causticity is destroyed, and the quick-lime rendered *mild*, and *insoluble*, by *restoring* its *fixed air*.

Now crude *sal ammoniac* is a combination of the *marine acid* with the *volatile alkali*; but it naturally contains no *fixed air*. *Quick-lime*, therefore, when joined with *sal ammoniac*, in order to make the volatile spirit, detains the acid of the crude salt, and suffers nothing but the volatile alkali to rise along with the phlegm in the distillation: But this spirit, so raised, having no *fixed air* in its composition, cannot effervesce upon the addition of an acid; for effervescence depends on the fixed air of the mixture flying off, and resuming its elasticity, while the acid and alkaline particles are rushing into close union*; nei-

* Vide Boerhaav. *Element. Chémie*, tom. i. p. 531. & tom. ii. p. 398.

ther can the particles of the volatile salt run together, and form chrystals, because air is the *bond of union* in this salt. But when *chalk* or *fixed alkaline salts* are used in the distillation, these substances, being replete with *fixed air*, send over some of it along with the volatile alcali; and this air renders the spirit mild and effervescent, and enables the salt to put on the concrete form.

NEUMAN imagined, that “perhaps the quick-lime absorbs, and detains the earthy matter, which is the basis of the volatile salt, and on which its solid form and its effervescence with acids depend.” And he relates, “that on keeping spirit of sal ammoniac, made with quick-lime, for ten years, it lost almost all its volatility and subtilty, and in this state effervesced strongly *”.

BUT

* *Neuman's Chemistry by Lewis*, p. 223.—*Du Hamel's* theory is, that when sal ammoniac is distilled with chalk, or fixed alkaline salts, some portion of earthy matter comes over with the volatile alcali, and enables it to form a concrete salt; whereas, when quick-lime is used, no earthy particle rises in the distillation; though it does not appear why the earthy matter should not rise as readily from quick-lime, as from chalk or fixed al-

E

cali.

BUT there is not the least occasion for waiting so long to produce this change in the nature of the *caustic volatile alkali*, since it may at any time be brought about in ten minutes by transferring the air from some other substance into the *non-effervescent spirit*; as any one may easily satisfy himself by the following exceedingly pretty and conclusive experiment, which is the contrivance of Dr. *Black*, and communicated by him to my very ingenious friend Dr. *Francis Hutcheson*, lecturer of chemistry, in the university of *Dublin*.

PUT a small quantity of the volatile spirit made with quick-lime into the little phial marked A, in figure 2, and fix closely into its neck, so as that no air may escape, one leg of the bended glass tube (B) and insert the other, and likewise lute

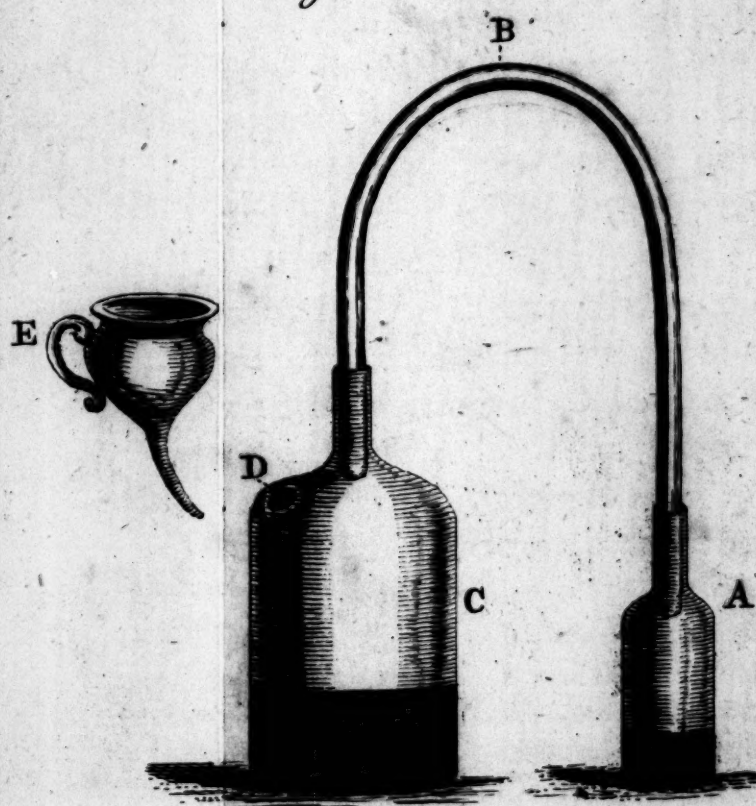
cali. He likewise adds, that as lime has the property of detaining gross oily matter, it keeps down the gross part of the volatile alkali, which is of an oily nature, and lets only the more subtile part come over with the phlegm in the distillation; and hence, the spirit made with quick-lime becomes so much more pungent and volatile.

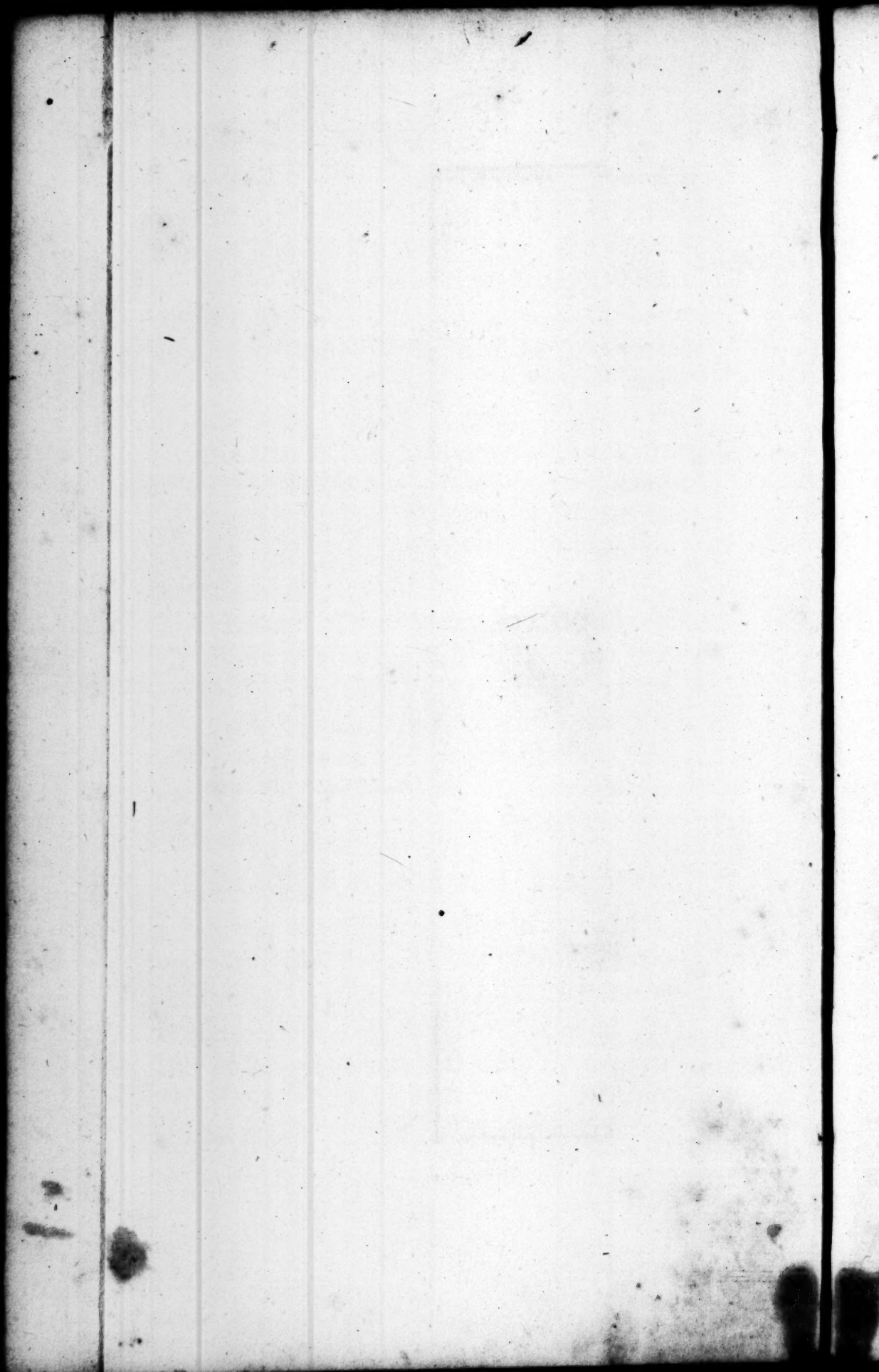
See the 2d & 3d memoir on sal ammoniac in *Mem. de l'Acad. Royale des Sciences*, for the year 1735.

it

facing p. 50

Fig. 2.





it well, into the mouth of a larger phial (C) into which some alkaline salt hath been previously put. This phial must have a little hole drilled in the upper part of it, as at D, that through this aperture, and by means of the small glass funnel (E) an acid may be gradually dropt in.

THINGS being thus fixed, pour in spirit of vitriol, or any other acid, that an effervescence may ensue; and while that is going on, the little hole (at D) is to be stoppt occasionally, in order to force over the extricated air into the phial A. An ounce of alkaline salt expended in this manner will serve to supply a like quantity of *caustic* alkaline spirit with a sufficiency of air to make it effervesce very smartly, when the phials are separated, and an acid dropt into the one which contains the (before) *non-effervescent spirit*.

EXPERIMENT 10.

MANY of the preceding experiments have shewn in the strongest light, the fermentative power of the *saliva*: I determined, however, to try it once more, and to compare it with the *bile*, in regard to this quality.

E 2

I THERE-

I THEREFORE mixed an ounce and half of bread and water, beat up thin, with half an ounce of *saliva*: and the same quantity of bread and water, with half an ounce of *ox-gall*.

THE first mixture shewed signs of motion from the very beginning, and, in less than an hour after it became warm, the motion was brisk; the second, with the gall, was not so soon in motion, it being three hours before the bread had all fairly risen to the surface; but the fermentation continued twice as long, and the motion was more brisk than in the mixture with the *saliva*.

AND thus it appears very plain that the *bile* has a power, like other animal fluids, to raise a fermentation, when mixed with vegetable substances.

EXPERIMENT II.

TWO drachms of boiled mutton, perfectly sweet, were beat up with an ounce of water, and put into one phial; the same quantity of the mutton beat up with half an ounce of *saliva*, and as much water, were put into another phial; and both of them left in the common temperature of the air,

air, which was cool for the season (beginning of June) the thermometer being at 60.

IN thirty-six hours, the contents of the first phial became putrid; the other, which had the *saliva*, remained sweet for forty-eight hours; but both of them fermented; that is to say, an intestine motion took place, the solid part all rose to the surface, and bubbles of air repeatedly formed, and continued discharging themselves, for several hours before any putrid smell was perceivable.

EXPERIMENT 12.

A DRACHM of boiled mutton, perfectly sweet, beat up with an ounce of water, was put into one phial; the same mixture was put into another, and a bit of thread being dipt in some putrid liquor which lay about rotten beef, about the tenth part of an inch of this thread was cut off, and thrown into the phial.

IN twenty-four hours, the contents of the second phial, after undergoing the intestine motion, were found putrid; the first did not betray the least putrid smell until it had stood twelve hours longer.

I REPEATED this with *bile*, and found the phial into which I had put the bit of putrid thread began to smell several hours sooner than the other, which contained *bile* and water only.

THESE experiments confirm the eighteenth of Sir *John Pringle's*, and plainly shew, that bodies in a state of putrefaction are *exciting ferments* to such as are sweet.

EXPERIMENT 13.

IT has appeared from the sixth of these experiments, that the *cortex* ferments very readily when joined with a mixture of animal and vegetable matters, and even seems to promote that fermentation; but I was desirous to know how it would operate when joined only to the *saliva*.

WITH this view, I mixed up a drachm of the *bark* in powder with half an ounce of *saliva*, and as much water. At first there did appear some signs of motion, but they presently went off, and at the end of eighteen hours I found the mixture perfectly at rest, notwithstanding it had stood the first six hours of this time in a moderate degree of heat; for the last twelve, indeed, it had been suffered to cool.

I NOW

I now added half an ounce of *ox-gall*; but no motion ensued till twenty hours more were elapsed: Then I found the solid part getting up to the surface, and the air-bubbles collecting and discharging; but it is to be observed that the phial, all this while, remained in the cold.

FINDING the motion begun, I placed the mixture in a moderate degree of heat, and then the fermentation became extremely brisk, and continued so for twenty-four hours, throwing off great quantities of air; after which it ceased, owing, as I conjectured, to the frequent agitation of the phial, which, as hath been before observed, considerably hastens and shortens the periods of this kind of fermentation.

EXPERIMENT 14.

IN order to close this series of experiments, I thought it would not be improper to try the several common *farinacea*, and to compare them with each other, in regard to their respective fermentative qualities; as this might be of use in determining which of them are easiest of digestion.

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HAVING

HAVING made up four mixtures, of wheat, barley, oats, and rice, all previously freed from their outward shells or husks, and well-boiled, so as to burst the grain, and beat up with the usual proportion of water and flesh meat *, they were then severally put into phials, and placed in a moderate degree of heat, about twelve hours after they were first mixed.

It was not easy to say whether the rice or the barley began first, for both of them were in brisk motion by the time that they had stood an hour in the warmth; the mixture with the oats was not in motion till about four hours after it became warm, and the one with the wheat was three or four hours later than it.

THEY all fermented very briskly, and being often agitated, ran through their first stage in about forty-eight hours.

THUS we may infer, that crude barley † and rice will prove light and easily digestible food; oats next to them; and wheat the most stubborn and indigestible of all. But at the same time we see, that this pro-

* Boiled veal was used in this experiment.

† The barley here used was what is commonly termed pearl-barley.

perty in wheat renders it by much the fittest of all the *farinacea* for the making of bread; as it appears to have firmness sufficient to enable it to bear some degree of fermentation in the baking, and yet retain enough of its substance to undergo the alimentary fermentation afterwards in the body.

By this time I had sufficiently satisfied myself with respect to the manner in which digestion is carried on in the human body; being now fully convinced that it is neither more nor less than a true fermentatory process: For if we consider the end of digestion, which is thoroughly to change, separate, and resolve into their constituent particles, the different substances on which we feed; and since we see that all mixtures of animal and vegetable substances, if furnished with the requisite quantity of water, and kept in the proper degree of heat*, naturally and spontaneously run into fermentation, without the assistance of any *exciting* ferment, how is it possible to think otherwise, than that the same kind of mix-

* Even heat, we find, is not always necessary; so prone are many of this sort of mixtures to ferment.

tures must ferment in the body, when at their very first entrance they meet with a fluid, which, even if their own natures were averse from fermentation, would immediately bring it on? And as they pass farther on, into the *stomach* and *duodenum*, they still meet with more fluids, endued with the same power, in an equal, or perhaps superior degree: Can it be imagined then, that these substances, when so circumstanced, will not undergo the changes natural to them? and that a fermenting motion will not instantly commence, and continue so long as they remain in a place where they are free to act, uninfluenced by any more powerful ferment; that is to say, so long as they remain within the confines of the *smaller intestines*? But soon after the *valve* of the *colon* is passed, and that the alimentary mixture, which as yet is only in its *first* stage, comes into contact with the *acido-putrescitive* contents of the larger intestines, then is its sweetness destroyed, and it proceeds on to the *second* and *third* stages, and thereby acquires a degree of sharpness and corruption*,

* It is to be observed, however, that the putrefaction of the *faeces alvine* is of a peculiar kind; and is never,
ex-

which is now become as necessary as it was that the sweetness should continue while the food remained in the first passages.

EXPERIMENT 15.

A DRACHM of salt of wormwood being put into one of the cylindrical glasses described in page 34. and which was used to cover the phials, and an ounce, or thereabouts, of juice of lemons, being poured on the salt, the mouth of the glass was stopt, while the ebullition continued, in order to confine the air which was extricated from the mixture.

WHEN the effervescence ceased, a *live sparrow* was thrown into the glass, and in less than half a minute expired.

THUS we see that the air which is extricated from bodies by effervescence, as well as that which is set free in the first stage of fermentation, and constitutes the *gas sylvestre*, hath the deleterious quality of suffocating animals.

excepting in some morbid cases, so complete as to furnish a *volatile alkali*, on being committed to distillation.

BUT

BUT *sal absynthii*, and *succus limonum*, are often given during the ebullition, and I believe, there can be no instance shewn of any person's being destroyed by it, notwithstanding what we have just now seen in regard to the sparrow which was suffocated by the vapour arising from such a mixture; therefore, the action of this extricated or factitious air is very different, when applied *directly* to the *lungs*, and when pent up in the *bowels* of a living animal.

The fear which the *physiologists* conceived of this deleterious quality in the *subtile gas*, and their not well knowing how to dispose of the great quantities of *air* which must necessarily be thrown off, if the aliment were supposed to ferment, seem to have been the chief obstacles that prevented them from embracing the doctrine of alimentary fermentation.

BUT it seems now proved, that we have nothing to apprehend with regard to the first; and in respect of the latter objection, the experiments above recited, plainly shew, that the air which is set free, either from a *fermenting*, or from an *effervescent* mixture, although it be at first truly *elastic*, yet

yet is of such a surprizing nature as to be capable of returning to a *fixed*, or *non-elastic state*, the moment it meets with any absorbent body that has power to receive it.

AND if we consider that this *air*, which is extricated from the food, has the whole extent of the alimentary canal to spread and diffuse itself through, we shall find that it never can create any uneasiness*, excepting when some acrimonious matter, or other stimulus though more remote (as in *icteric*, *hysteric*, and *nephritic* cases) occasions a spasmodic constriction in some part

* In habits where the whole system of living solids is too much relaxed, whether from intemperance, profuse evacuations, or previous disease, the muscular fibres of the stomach are apt to yield too freely to the elastic vapour, which is thrown off in the commencement of the digestive process, which must necessarily bring on immediate distress, from the over-distension thus created; but the parties thus afflicted generally have recourse to a speedy, though otherwise dangerous, remedy, spirituous liquors: Drams, when swallowed soon after the meal, not only encrease the muscular power of the stomach, but also retard the alimentary fermentation, and thereby give time, before it be far advanced, or that much air is set free, for the food to pass on into the intestines, where the elastic vapour having so much more room to diffuse itself, no uneasiness or oppression will ensue.

of the tube, and prevents thereby the free and equable diffusion of the elastic vapour.

On the contrary, the usual, natural, and gentle degree of distension is of the greatest importance to the animal œconomy; for it stimulates the muscular coats of the stomach and intestines, and thereby excites, and keeps up, their peristaltic motion, and enables the *lacteal*, and other minute vessels, to *absorb* freely; neither of which (the motion nor absorption) could be well carried on, if the sides of this long canal had been suffered to collapse *.

* When all the viscera of the abdomen are compressed by the descent of the diaphragm during inspiration, the chyle contained in the lacteal veins is pushed on towards the receptacle, because the valves of these veins will not allow it to return back into the intestines. Hence, that portion of the lacteal, which lies between the first valve, and the orifice that opens into the intestine, will be intirely emptied; but the moment the diaphragm ascends in expiration, and the pressure is taken off from the contents of the lower belly, the elastic air, in the intestines, will force the chyle into the aforementioned void spaces of the lacteal veins, in the same manner, and on the same principle, that it raises the water in a common pump, while the piston is lifted up.

This is the way in which M. *Senac* accounts for the absorption of the chyle.—See his memoir in the *Mem. de l' Acad. R. des Sciences*, for the year 1724.

THEN,

THEN, so much of it as is left unabforbed (for we have seen that the fermenting mixtures, after a certain time, resorb the air, which at first flies off in an elastic state) entering the composition of the chyle, it stimulates the vessels appropriated to the carrying of that liquor, and promoting their oscillatory motion, enables them to pour their contents, in a very short space of time, into the general mass of blood.

HERE the intestine motion is communicated by this active principle, the *elastic air*; while every moment it meets with new powers*, which reduce the requisite proportion to a *non-elastic state*, and leave the remainder in possession of its *elasticity*:

* This is ascribed, by Dr. Hales, to the sulphur which is in bodies; and he seems to have been led into this opinion from observing, that the fumes of common sulphur have a prodigious power to absorb and destroy the elasticity of air.

But whether it be in reality the sulphur-principle, or phlogiston, as it is now more generally termed, that has the property of fixing, and reducing to a state of non-elasticity, this air, which we find is thrown off from bodies while they are resolving into their several component parts, cannot possibly be determined from any discovery hitherto made. See *Hales's Stat.* vol. ii. p. 108.

which

which is necessary, to maintain the intestine motion, and to serve as a counterpoise to the pressure of the atmosphere.

I AM well aware, that this assertion concerning *elastic* air in animal fluids is directly contrary to the doctrine of *Boerhaave*, who in express terms, condemns the theory of *Borelli*, in relation to this matter.

THAT great man taught, that the air which is found in bodies of all kinds, and particularly in animal fluids, is there in such a state as to be altogether incapable of acting as air: He thought, that it was divided into such extremely minute parts, that its particles were *solitary*, and that, while they remained in this divided and solitary state, they had no power to exert any of the properties of air; but that when two of these particles came within the sphere of each other's action, then they acquired the *repulsive power*, and became *elastic*; and being joined by a third, a fourth particle, and so on, they then burst forth in the form of genuine bubbles of air.

BUT as these particles are kept in their *solitary state* by the weight and compression of surrounding matter, or by the pressure
of

of the atmosphere, and as they never break loose but when the texture of bodies is destroyed, by fire, effervescence, fermentation, or putrefaction; or by removing, almost entirely, the weight of the atmosphere, he contended, that the air in animal fluids, should not be regarded as air; neither should we expect it to exert any of its usual properties; seeing that, while life continues, no such changes as those above specified, ever do happen*.

BUT *Hoffman* and *Dr. Hales* are as explicit on the other side of this argument; and some of the experiments of the latter fully authorize him to be so. His opinion is, that there is a "considerable quantity" of air in vegetables upon the wing, and "in a very active state;" and that this elastic air invigorates the juices of both animals and vegetables, while it continues in this state of activity†.

* *Quin et ratum est, aera latentem in liquoribus, non habere illas vires physicas quas possidet dum extra liquores unitus existit. Igitur in chylo, lacte, &c. adest aer naturaliter, sed ita dissolutus, atque proinde tandiu non agens ut aer. Boerhaav. Elem. Chemie, tom. i. p. 519, 524, 525. Corroll. 6, 7, & 8. Vide quoque Praelectiones Academicas, tom. ii. p. 199.*

† See the experiments in the third chapter of the first

It appears also that the elastic air, which is mixed with the animal fluids, always preserves the same tenour with the external air; for if this were not so, the sides of the vessels must frequently burst asunder; since even the common changes of the atmosphere, in its usual variation, within the compass of three inches of the barometer, would make such an alteration of pressure as no living body could endure*.

BUT when we are told, that the atmosphere is so light on the tops of exceedingly high mountains, that it is scarce able to sustain a column of mercury of sixteen inches†; and so heavy in the bottom of deep

volume of the *Statics*; and also p. 216, 315, of the same volume.

* This difference is calculated by Dr. *Wainwright* to amount to more than a ton and a half (3982 $\frac{1}{2}$ pounds Troy weight.)

† The *French* Academicians, who went to *South-America* in the year 1736, in order to measure a degree of the earth's surface, found that the mercury which stood in the Barometer at 28 inches (their measure) on the sea-shore, fell to less than 16 when they ascended the high mountains in the province of *Quito*.

At the city of *Quito* it seldom rises above 20 inches, and yet these gentlemen felt no distress from breathing,
in

deep mines, that it can support a column of *thirty-one* inches; and when we know from experience, that a man may *ascend* in the one case, and *descend* in the other, and yet feel no great inconvenience, we may be certain that an *equilibrium* is kept up, otherwise the vessels must be ruptured in both cases: In the first, because of the expansive force of the air contained in them; and in the second, by means of the immense weight of atmospheric air pressing upon them. The difference between the weight which presseth on the body of a man in one of the *Newcastle* coal-pits, and what would press upon the same man if he in so light an atmosphere, except on their first going there, when some of the company, who had weak lungs, spat a little blood, but these complaints gradually wore off.

On the mountain called *Pinchincha*, where the Academicians fixed one of their stations (for taking the triangles) the mercury generally stood at 16 inches; but one day Messrs. *Bouguer* and *de la Condamine* climbed up to the summit of a still higher mountain, named *Chouffalong*, where the mercury stood at only 15 inches and 9 lines, being near 12 inches less than what it rises to, on a level with the sea.

See Voyage de Messrs. *Bouguer et de la Condamine*, pour determiner la figure de la Terre.

were on the top of one of the *Andes*, being calculated to amount to something about eight tons *.

MANY of the physiologists have imagined, that the animal fluids are furnished with air by the lungs; but the objections † against this opinion are such as cannot easily be surmounted; they must therefore be supplied by the way of the *chyliferous*

* The mechanical physicians account for this matter by saying, that the impetus of the heart increases as the resistance to the circulating force of the blood increases.

“ The weight of the air increasing, the lungs will
 “ be more forcibly expanded, and hereby the blood
 “ more intimately broken and divided, so that it be-
 “ comes fitter for the most fluid secretions, such as that
 “ of the animal spirits, by which the heart will be
 “ more strongly contracted. The blood’s motion to
 “ the surface of the body being obstructed, it will pass
 “ in greater quantity to the brain, where the pressure
 “ of the air is taken off by the cranium, and upon this
 “ score more spirits will be separated, whereby the
 “ heart will be so strongly contracted as to carry on the
 “ circulation through the passable canals, whilst some
 “ other are obstructed.” *Wainwright on the Non-na-*
turals, p. 92.

† They may be seen at large in *Haller’s Elementa Physilogia*, tom iii. and in *Hoffman*, in the chapter de *Sanguinis Circulo per Pulmones*.

canals

canals, and that in no small quantity; for the air, like all the other constituent parts of the animal fluids, will require to be perpetually renewed: old particles will every moment fly off, and new ones must of course succeed.

THERE are many ways of proving the existence of air, in every part of an animal body.

DR. Hales found, that "a cubic inch
" of hog's blood, distilled to dry scoria,
" produced 33 cubic inches of air, which
" air did not arise till the white fumes
" arose." (*Exp. 49.*)

" LESS than a cubic inch of tallow,
" being all distilled over into the receiver,
" produced eighteen cubic inches of air."
(*Exp. 50.*)

" HALF a cubic inch of the tip of a
" fallow deer's horn being distilled, pro-
" duced 117 cubic inches of air, which
" did not begin to rise till the white fumes
" arose." (*Exp. 51.*) " Thus it appears,
" that the cohesion of animal substances
" was not dissolved, even in the blood,
" without considerable violence of fire;
" though it is sometimes done to a fatal

“ degree, in our blood, by that more sub-
 “ tile dissolvent fermentation *.”

“ SIXTEEN cubic inches of sheep’s
 “ blood being put into a bolt-head, with
 “ a little water to make it ferment the
 “ better, in eighteen days generated 14
 “ cubic inches of air.” (*Exp.* 80.)

So far Dr. *Hales*; but I was desirous of knowing whether the *fixed air* would pass from a putrefying, animal substance, into the *caustic* volatile alcali, so as to make the said alcali become *mild* and *effervescent*.

EXPERIMENT 16.

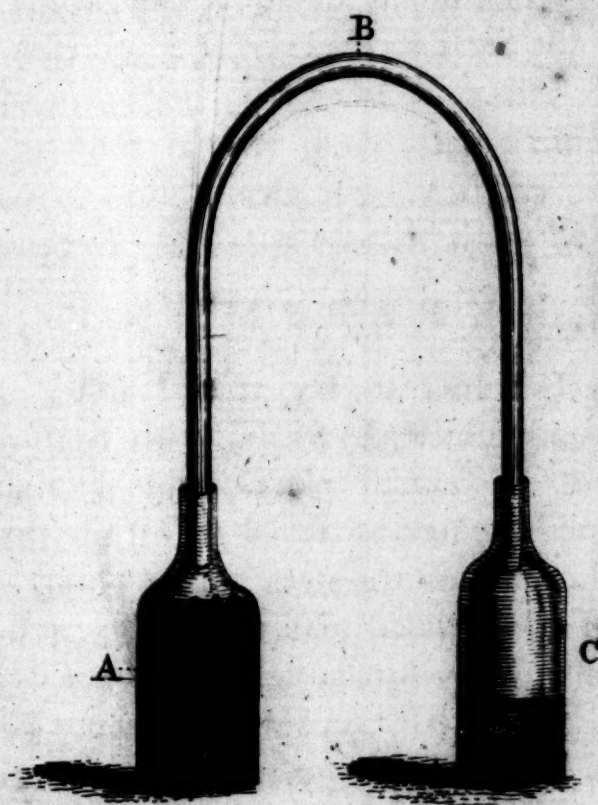
In order to try this, I filled the two ounce phial (A) fig. 3, with fresh mutton, cut into small pieces, and poured in as much water as served to fill up the interstices; into the neck of the phial, one leg of the bended glass tube (B) was inserted, and closely luted; and the other fixed into a little phial (C) containing about a drachm of the spirit of *sal ammoniac* made with *quick-lime*.

* As Dr. *Hales* held putrefaction to be only a degree of fermentation, he therefore useth the terms promiscuously.

THE

facing p. 79.

Fig. 3.



THE phials thus joined together, were hung up in the common temperature of the air. In four days the elastic vapour, in the larger phial, had so expanded itself, that the liquor was raised some inches in that leg of the tube which belonged to it, but upon agitation it subsided: And this agitation I was afterwards obliged to repeat several times, otherwise the putrid liquor would have run over into the small phial.

WHEN they had remained in this situation for a fortnight, and that I saw the mutton was become highly putrid, I took off the small phial with the alkaline spirit, and found, upon dropping in spirit of vitriol, that a violent effervescence ensued. So that here was a *demonstration*, that during the progress of putrefaction, there is continually some volatile matter flying off from the putrifying substance, and that this fugitive principle is *air*, which is now extricated, and thrown off, from a *fixed* and *non-elastic* state, into one that is *volatile* and *elastic*; but which, immediately upon meeting with a proper recipient, returns again to its former nature.

THE

THE common notion concerning putrefaction, which is universally taught, and as generally believed, is, that bodies become putrid because that air hath access to them, and communicates somewhat; and few people seem to have any idea that putrefaction ensues in consequence of the loss of some principle; which, however, appears to be the real cause. For it will be shewn hereafter, that the methods to preserve bodies from putrefaction and decay depend, almost in every instance, on *restraining the flight of the fixed air*; for, as this principle *cements and binds together* the constituent particles of bodies, rottenness, or putrefaction, which ensues in consequence of the *resolution and disunion* of these particles, will not take place while the *cementing principle* is present.

BUT, in order to determine somewhat, if possible, concerning this affair, I made the following experiment.

EXPERIMENT 17.

IN the beginning of June, the thermometer being then about 60, I took three little pieces of fresh mutton (of about 3i) one was put into a tea cup, and melted

suet poured all around, so as to cover it intirely; the second was placed under a cupping glass, which rested upon a piece of wet leather lying on the cover of a book; and all the air that could be exhausted was pumped out of the glass, by means of the little air-pump belonging to it; and the third piece of the mutton was left exposed to the open air of the chamber.

At the end of sixty hours, the piece in the open air, though a good deal dried, was found to have grown evidently putrid. I then went to examine the piece in *vacuo*, and could plainly perceive by its appearance through the glass, that it was become highly putrid, for it had grown mouldy; and upon lifting up the cupping glass, which was now loosened from the leather on which it rested, the smell sufficiently confirmed this appearance; for the putrid stench was by many degrees more offensive and strong than in the piece which had been exposed to the open air.

UPON uncovering the bit of mutton which lay involved in the suet, it was found perfectly sweet.

EX

EXPERIMENT 18.

I RESOLVED, however, to repeat this experiment, and that with a still greater degree of accuracy and attention; and for this purpose having provided a tight *air-pump*, I took *four* little pieces of fresh beef; the first being weighed, its weight was found to be exactly 458 grains: this piece was placed at eight in the evening (thermometer being at 70) under a small receiver, and all the air that could be exhausted was pumped out; the second piece weighing 431 grains, was covered with an inverted glass of the same capacity with the receiver, and rested on a piece of wet leather, spread over the bottom of a China plate; the third piece of the beef, which was nearly of the same bulk with the other two, I put into a cup, and poured melted suet all around, and over it; and the fourth piece of the beef was hung up in the open air, on the north side of the house.

WHEN twenty-four hours were elapsed, I took out the piece of beef which had lain *in vacuo*; it had fairly got the offensive putrid smell, and being weighed, was found

found to have lost between seven and eight grains.

THE piece, No. 2, which had lain under cover, was still perfectly sweet, and had lost only two grains and a half.

THE piece in the open air was almost dry, and perfectly sweet.

THE piece covered over with suet was not examined, as I intended it should remain in that situation for some days longer.

HAVING placed No. 1 again under the receiver, and exhausted the air, it was left there till morning; when being again examined, it was found quite putrid, and wanted fifteen grains.

No. 2 had now likewise got the putrid smell, and being weighed, was found to have lost but five grains in all; so that the piece which had lain *in vacuo* lost upwards of $\frac{1}{10}$, while the other wanted only $\frac{1}{10}$ part of its original weight.

THIS loss I looked upon to be chiefly air, for both the pieces appeared and felt as soft and moist as they did at first; and as they had lain both of them upon wet leather, which is but little adapted to absorb watery vapours, I did not imagine that

that much of the aqueous part could have been exhaled from either ; but the difference of loss between the two must have consisted entirely of air, since the circumstances of both pieces were exactly alike, with regard to the exhalation of their water, both of them being inclosed in vessels of the very same size, and both of them alike excluded from communication with the external air.

THE piece which had been exposed to the open air, was found, in thirty-six hours, to have grown perfectly hard and dry ; but was quite sweet, and remained so, being now rendered incapable of putrefaction, by reason of the sudden exhalation of its aqueous part ; for, as hath been elsewhere observed, there can be no fermentation, and consequently no putrefaction, without the requisite quantity of water ; for water, by giving fluidity to bodies, allows the other principles to shift their places, and to exert their several peculiar attractive and repulsive powers, which they cannot possibly do in a state of too much dryness.

AND hence we see the plain and obvious reason why a moist atmosphere promotes

motes putrefaction; for, independent of the putrefactive *miasmata*, which are sometimes contained in it, and which act upon bodies as ferments, at the same time that the escape of the fixed air is favoured by the smaller degree of pressure, all the water of the putrescent substance is left behind; and even in some cases this very water is increased, which adds to the fluidity, or softness of the body thus exposed.

HAVING suffered the piece which was covered with melted suet to remain untouched for three whole days and a night, I opened it, and found the beef perfectly sound, soft, and sweet; but it grew very putrid in eight or ten hours after it was uncovered, and that a way was made for the fixed air to escape.

EXPERIMENT 19.

I REPEATED this experiment again with two pieces of fresh mutton; the weight of the first piece, which I put under the exhausted receiver, was 573 grains; the other, which was covered by the inverted glass, weighed 554 grains.

AFTER

AFTER remaining twenty-four hours, I found them both tainted, the weather being at this time very moist, as well as warm; but upon weighing, the proportion held nearly as before; for No. 1 lost more than five grains, while No. 2 wanted only two.

EXPERIMENT 20.

I THEN took two fresh eggs, which had been laid the same day, and put one of them under the receiver, where it was kept for a week, and the air-pump wrought generally once in the day, in order to keep it as much exhausted as possible; the other egg was left in the open air. At the end of the week, I broke them both, and found the one which had been under the receiver, though it could not be said to be rotten, yet had acquired some degree of *fætor*, and the yolk did not appear near so firm as in the one which had been exposed to the open air.

THE broken eggs happening not to be thrown out, I found the one which had been kept in the receiver of the air-pump quite putrid and offensive, on the following morning, while the other remained perfectly sweet.

It

It is universally known, that eggs, when coated over with melted suet, or some such unctuous matter, will remain fresh and sound for many months*.

EXPERIMENT 21.

WITH the apparatus belonging to an air-pump, there are generally two hemispheres of metal, contrived to join closely together, so as that when the air is pumped out of the cavity, the two remain firmly united by the mere pressure of the atmosphere.

It did not at first occur to me, that it would be best to inclose the pieces of meat that I wanted to make the experiments on, in this hollow globe, which promised to exclude the external air more effectually than was done in the former way.

HAVING therefore inclosed a piece of sweet and fresh mutton in this sphere, and left another, of the same bulk, under cover of a glass, they were both suffered to remain in those situations for forty-eight hours.

UPON examination, the piece which had

* See the Memoir of M. de Reaumur on this Subject, in the Mem. de l' Acad. for the Year 1735.

been

been inclosed in the hollow sphere was found sweet, and the other putrid.

UNTIL now, I had been inclined to think that Mr. Boyle, and the other writers who assert that bodies do not become putrid *in vacuo*, were somehow or other led into a mistake; for as the four preceding experiments plainly shewed that putrefaction is accelerated by taking off the pressure of the atmosphere, I had almost concluded that putrefaction will sooner take place *in vacuo*, than in the open air.

BUT on finding from this last mentioned experiment (where the *vacuum* had been more complete, and the communication more effectually cut off than by means of the glass receivers) that the piece of mutton inclosed in the hollow sphere, did not become putrid in the usual time, I presently perceived that the former ones had not been made with sufficient accuracy.

WE may therefore very safely subscribe to the experiments formerly made by Mr. Boyle, and since repeated with still greater precision by the late very celebrated M. Eller of Berlin, which shew that substances even of the most putrescent nature (such as blood)

blood) may be preserved sound *in vacuo* for many years.

As taking off the pressure of the atmosphere accelerates putrefaction, so the increasing of this pressure will retard it.

E X P E R I M E N T 22.

In the month of *July* I took two pieces of fresh mutton of about half an ounce each, and put one of them into a hollow sphere belonging to an air-gun *, and by means of the condenser which is contrived for throwing air into the cavity of the sphere, I forced in as much as I conveniently could; the other piece of the mut-

* This air-gun (as improved by Dr. *Ellis*, and made by *Margas, Dublin*) is constructed in a manner somewhat different from the common ones; the chamber for containing the condensed air not being in the stock as usual (which makes the machine heavy and unwieldy), but it has five or six hollow spheres belonging to it of about three inches diameter, fitted to screw on the lock of the gun: these spheres are contrived with valves to confine the air, which is forced into their cavities, so that a servant can carry them ready charged with condensed air; and thus the air gun of this construction is rendered as light and portable as one of the smallest sized fowling pieces.

ton was put into a sphere of the like sort, but without forcing in any air.

THEY were both laid aside for four days, and then opened: the piece of flesh that had been inclosed in the sphere with the condensed air, was firm, sound, and perfectly sweet; the other piece of the mutton which lay in the sphere without condensed air, was found extremely soft, and highly putrid.

HERE then we have a demonstrative proof that bodies do not putrefy, because that air *adds* somewhat to them; for if they did, then the piece of mutton which lay in the condensed air ought to have putrefied the soonest, because it had the greatest quantity of air applied to its surface.

BUT the reason why condensed air prevents putrefaction, is exceedingly obvious and plain from the theory already laid down; since the pressure on every side must force the constituent particles closer together. This of course increases the cohesion, and prevents the intestine motion; and, as hath been already said, without intestine motion there can be no change of combination.

SIR

SIR *John Pringle* having found the *testacea*, and absorbent earths, to be promoters of putrefaction, this seemed the proper time for repeating those experiments.

EXPERIMENT 23.

ACCORDINGLY, I began with chalk, and the *pulv. e. chilis cancrorum comp.* of the shops; two phials, each with half a drachm of these powders, mixed with an ounce of water, had severally a small bit of fresh beef put into them; a third phial, with nothing but water and a bit of the same fresh beef served as a standard.

IN thirty-six hours, the two phials with the absorbent powders had both got the putrid smell; in three hours afterwards, the piece of beef in the third phial became likewise fetid.

EXPERIMENT 24.

A LIKE quantity of the *chalk* and *pulvis e. chelis* was put into two phials, with an ounce of water in each, and half an ounce of fresh ox-gall. A third phial, with nothing but gall and water, served as a standard.

84. On the NATURE and

IN thirty-six hours, the two first phials were found putrid; the third maintained its sweetness for about six hours longer.

EXPERIMENT 25.

HALF a drachm of the earth of allum, mixed with an ounce of water, and a little bit of fresh mutton, were put into one phial; half a drachm of *magnesia alba*, mixed with an ounce of water, and a bit of the same mutton, were put into a second phial; a third bit of the mutton was left in a cup, with common water, for a standard.

IT was about three in the afternoon that these mixtures happened to be made, they were all sweet at bed-time on the succeeding night, after having stood thirty hours; but next morning, the mutton, in both the *magnesia* and the standard, was found putrid, but the *magnesia* rather more so than the simple water.

THE earth of allum preserved its piece of the mutton twelve hours longer, and rendered it somewhat hard; possibly, some small remains of the acid adhered to the earth, which gave it this slight degree of antiseptic powder.

SIR

SIR John's conjecture about the manner of operating of these absorbents, is, that they destroy the *latent acid*.

THIS *latent acid* is supposed to enter into the composition of animal bodies, and is conceived to be one of the chief ingredients in the cement between the particles that constitute the fibres; *chalk* and *testacea*, therefore, act as dissolvents, by being the proper absorbents thereof.

THIS *latent* principle, however, is allowed to be so much out of the reach of demonstration, that he says, "It may be hard, or even impossible, to produce it in a simple form."

BUT there is another principle in animal bodies, of whose existence there can be no doubt, the *fixed air*.

CALCAREOUS earths have a very strong affinity with this fixed air; and though, in a natural state, they abound greatly in this principle, yet from their action of hastening putrefaction, it appears that they are not so replete with it, but that they are still capable of extracting some from an animal substance, and thereby promoting the intestine motion. For the extraction of *some portion* of the fixed air seems suffi-

cient to throw the remainder of that element into action, and thereby to raise the intestine motion; because, when the fixed air flies off spontaneously from any substance, it always resumes its *elasticity*, or *repulsive powers*, in the *instant* of its extrication; and this *repulsive power* puts the other principles into motion.

BUT when the *whole* of the *fixed air* is withdrawn from a body, by any substance having a stronger affinity therewith, such as *quick-lime*, then the *fixed air*, so attracted or absorbed, does *not regain* its *elasticity*, but passeth, in a *non-elastic* state, from one body to another; and hence ensues the *dissolution*, but not the *putrefaction*, of the body whose fixed air is so carried off.

EXPERIMENT 26.

I PUT half a drachm of quick-lime into an ounce of water, and immersed therein a little bit of fresh mutton. This mixture kept off the putrefaction, but it entirely dissolved the flesh, in about a week; not the least ill smell, however, was to be perceived, although I kept the mixture for three weeks in all.

SEEING

SEEING then, that *dead bodies* become putrid from the *loss* of their *fixed air* *, may not the immediate cause of putrefaction in *living* bodies be the detachment of too large a proportion of their *fixed air* ?

IN order too see what foundation there may be for this conjecture, let us take a view of the appearances which attend the putrefaction of animal fluids.

SIR John Pringle remarked, " That both the serum and crassamentum of

* I have just met with a book published at Vienna in 1762, wherein the author endeavours to establish a very extravagant theory concerning putrefaction and contagious diseases.

He insists, that bodies which are vulgarly supposed to putrefy, or to rot, are devoured by myriads of *animalcula*; that the *foetor* arising from such bodies ariseth from the excrements of the said *animalcula*; and that contagion is spread by their *ova* being waisted through the air, and carried from place to place.

Hence he attempts to account for the appearances in the small-pox, measles, scarlet fever, and all other contagious or infectious diseases; alledging the cause of all these to be a *materia animata*, or *seminum verminosum*.

The consequence of this theory is, that *mercury*, and the bitter *anthelmintics*, are the only things whereby we are to expect to do service in these diseases. *Marci Anton. Plenciz Opera Medico-Physica.*

“ human blood yielded air, after standing
“ some time in the lamp furnace, before
“ any offensive degree of putrefaction was
“ perceived.”

“ I HAVE known (says Dr. *Huxham* *)
“ the whole body swell vastly, even to the
“ ends of the fingers and toes, with a ca-
“ daverous lividity, though almost quite
“ cold, and an intolerable stench, even
“ before the person was actually dead;
“ blood issuing at the same time from the
“ ears, nose, mouth, and guts: And this
“ too where the pulse had been very weak
“ and small, though exceeding quick from
“ the very beginning. Was not this from
“ much air generated by the intestine mo-
“ tion, heat, and putredity, which are
“ well known to generate air? Is not the
“ *emphysema* observable in some sphacela-
“ tions, from the same cause?”

MANY symptoms of this sort, in the
scurvy, and other highly putrid diseases,
evidently shew that the air is actually de-
tached from the blood in these terrible
cases.

* In his *Treatise on the Malignant Sore-Throat*, p. 61.

LET us now observe the known causes of that degree of putrefaction, which often takes place in the *living body*.

FIRST, a long continuance in an *over-moist* atmosphere is known to bring on the putrefactive *diathesis*.

AN atmosphere full of water vapours obstructs perspiration, not only lessening the force of the solid fibres, and thereby disenabling them to propel the usual and natural proportion of perspirable matter to the surface of the body, but so much of this matter as is dissolved on, when it arrives at the proper outlets, finds an *atmosphere already loaded with water*, and consequently ill adapted, and little capable of absorbing much of the same kind of vapour.

BUT the perspirable matter consists of other principles beside *water*; its taste proves it to contain a large share of *salt*; and the reason of the thing may warrant us in asserting, that it has some portion of *earthy*, and *phlogistic* or oily matter, in its composition; and, in particular, that it carries off a great deal of *air* *.

THE

* Cum totum corpus nostrum innumeris tubulis & poris pervium atque vasculosum sit, per quod, continuo

&

THE lightest and most fugitive part of this excrementitious fluid, that is, its *aerial* part, may be carried off notwithstanding the moist state of the atmosphere will *not allow* the *aqueous* part to be exhaled: A great share of the water, therefore, and the three other principles joined to it, being left behind, now they are deprived of their air, are in a *putrefactive state*, and consequently may become *ferments* to the remaining mass of fluids.

IF we attend to the known methods of preserving health, while the body is exposed to too great a degree of moisture, the above hypothesis will appear the more rational; since experience teacheth, that this is most effectually done, 1, by keeping the body well covered, and wearing such kind of apparel as will most readily absorb the watery part of the perspirable matter which the atmosphere cannot absorb; 2, by using such a course of diet as will afford the animal fluids more than usual sup-

& perenni motu, æstuentes humores circumferentur, non mirum est, ingentem copiam tenuissimorum corpusculorum *aqueo-aereorum*, & *sulphureo salinorum*, modo sub forma vaporum, modo humoris, per illud evehi.

Hoffman, Med. Syst. Rational. pars iii. cap. vii. sect. 11.

plies

plies of air, to make up for the extraordinary waste, such as recent vegetables, fruits, sugar, and aromatics; 3, by eating sparingly of animal food, which yields a small proportion of air, and by abstaining from the *immoderate* use * of ardent spirits and fermented liquors, which check the alimentary fermentation, and hinder the free extrication of air from the substances fed upon.

SECONDLY, if the circulatory motion of the fluids be very much increased either by too violent exercise, or by a fever, and this extraordinary motion be continued, putrefaction most certainly ensues.

LET the original cause of animal heat be what it will, it is certain, that an increase of velocity, with respect to the circulation, always creates an increase of the animal heat. The effects of heat are well known; first, in expanding; then as it increases, dissolving; and at length, when raised to yet higher degrees, decompounding the substances which are exposed to its action. The first effect therefore of

* The moderate use of these liquors is found to be of service to strengthen and encrease the power of the solids, and thus enable them to keep up a due degree of perspiration.

an encrease of heat in the living body, is to expand the fluids and distend the vessels, so that the red colouring part of the blood gets into such canals as are naturally destined to carry only pellucid lymph; but as the heat and attrition increase, the texture of the blood is more and more changed, until at last it comes to suffer an actual decomposition: for as the insensible particles which make up the blood, are essentially different from each other, and are held together by the attracting power of some one particular principle (alleged to be the fixed air) so soon as the bond of union comes to be destroyed, in consequence of the increase of the repulsive power from the augmented heat, the natural and healthy texture of the blood will be dissolved, and the particles will run into new and irregular combinations.

THIRDLY, *mercury*, and many of the poisons, destroy the texture of the fluids.

THE action of *mercury* may be considered either as breaking down the particles of the blood by its extraordinary weight, and the force of mere mechanical attrition, or it may be supposed to act in consequence of its having a power to change the

the natural laws, which obtain among the repulsive and attractive powers of the several constituent particles: And this last seems to be the most plausible way of accounting for its operation; since the quantity of *mercury*, when rendered active by its being joined to some saline body *, which is found sufficient to melt down the blood, is so extremely small in many cases, that no mechanical action, arising from its weight, can be deemed equal to the effect. The action of poisons, to which are to be referred infectious *miasmata*

* The reason that mercury becomes so extremely active, when joined to saline bodies, seems to be this: It is now rendered capable of the most immediate and intimate mixture with the animal fluids, because of the affinity between water and salt; and being thus mixed with the mass of blood, can change the repulsive and attractive powers in such a manner as to produce a new combination among the constituent particles.

[This accords with the opinion of *Spielmann*, professor of Chemistry at *Strasburg*, as appears from his *Institutiones Chemicæ*, a book which I had not seen before the first edition of these Essays was published. “*Hydrargyrum vires suas attenuantes & resolventes, quibus omnia reliqua medicamenta vincit, tunc demum evidentissime valeat edere, quando, salium ope, in aqua dissolubile redditur, & ut humoribus humanis commisceri possit aptatur.*” P. 210.]

causing

causing putrid diseases, cannot well be accounted for, on any other principle than by recurring to a power of this last-mentioned kind; seeing their quantity is so exceedingly small, that, let them be supposed to consist of the sharpest of all possible darts or *spicula*, they never could occasion such alterations, or destroy the texture of the fluids in such a manner, as experience shews may be done, in a very short space of time, by the introduction of these subtle and active matters into the blood.

FOURTHLY, a diet consisting entirely of animal food, is generally followed by a putrefactive dissolution of the fluids.

IT is sufficiently known, that animal substances, when left entirely to themselves, run very speedily into the putrid state; and notwithstanding it appears, from the eleventh experiment of this essay, that the saliva has a power to retard the putrefaction of animal food, yet surely a diet consisting wholly of such, cannot fail of producing putrescent chyle, which, when carried into the blood, will communicate the same disposition to the general mass of fluids; but animal food appears likewise to yield but little air, as may be inferred from
remarking

remarking the structure of the alimentary canal in carnivorous animals, which is much shorter, has fewer *rugæ*, and does not at all seem adapted to the different degrees of distension, which the stomach and intestines of the creatures who feed altogether on vegetables, or on a mixed diet, are capable of.

THE mechanical physicians think they give a just idea of putrefactive acrimony when they tell us, that it consists in the letting loose of certain sharp-pointed particles, which either exist naturally in the fluids (but, in a healthy state, are prevented from doing any harm, by sheaths or *involutura* which cover them;) or, that these pointed particles arise from the breaking of the globules, which thus become sharp and angular, like the others before-mentioned; and, like them, are now capable of tearing, irritating, and destroying every thing they meet with*.

BUT the *soundness* and the *corruption* of animal fluids seem to depend more upon *chemical mixture*, than on *mechanical ac-*

* Vide *De Gorter de Perspiratione*, cap. vii. p. 42.

tion;

tion* ; and yet those chemists who made putrefaction and alcali much the same thing, and, in consequence thereof, were to cure all putrid diseases by acids, have not, by this theory, added much to the true improvement of medical knowledge.

SIR *John Pringle*, who has thrown great light on this subject, finding from the experiments which he made in the year 1750, that syrup of violets was not changed to a green colour by the serum of putrid blood ; that this serum did not make any effervescence when spirit of vitriol was poured on it ; that water, in which corrupted flesh had been some time infused, neither effervesced nor changed the colour of the syrup ; and that alkaline salts, both fixed and volatile, powerfully oppose pu-

* That is to say, animal fluids do not contain sharp-pointed or angular particles, that are capable of being obtunded, or brought into the globular form by merely rubbing against each other in the course of circulation. But these fluids consist of particles which all have their several peculiar affinities, or attracting and repelling powers, with regard to each other, whereby they are capable of forming a great variety of combinations, in a manner similar to what is observable in chemical mixtures.

trefaction ;

trefaction; could by no means bring himself to believe that putrid animal substances should be regarded as alkaline.

AND he continued to think still in the same manner, until he became acquainted with the experiments made by M. *Gaber* of *Turin*; in consequence of which, with that candour which is inseparable from the liberal mind, Sir *John* embraced the very first opportunity of acknowledging his mistake.

HAVING made several experiments in order to satisfy myself concerning this matter, I shall here lay an account of them before the reader.

EXPERIMENT 27.

HUMAN blood being left in a phial well corked, at the end of two months was found highly putrid; it had not separated into distinct parts of *serum* and *crassamentum*, but was all alike thick, being of the consistence of syrup, and of a dark red; or rather blackish colour.

SPIRIT of vitriol being dropt into some of this putrid blood, raised a smart effervescence, and converted it into a hardened spongy kind of substance.

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EX-

EXPERIMENT 28.

SIX ounces of this putrid blood being put into a small retort, with two spoonfuls of water, were distilled by a very gentle heat; about an ounce and half of a transparent liquor having come over, the receiver was taken off, and the liquor found to be a spirit with a very pungent, and peculiar fetid flavour, not like that of the blood from which it was obtained, but rather more approaching to the smell of rotten fish.

THIS spirit effervesced violently, with the acid of vitriol.

IT changed the juice of radish scrapings to a bright green*.

IT threw down a white precipitate, from a solution of corrosive sublimate.

IT turned a solution of copper in an acid, to a bright blue.

AND when saturated with the acid, and its pungency thereby destroyed, when some

* The scrapings of radishes afford a blue juice, which answers much better to try acids and alcalies than syrup of violets: The most convenient way is to dip little bits of linen-rag in the juice, and having dried them, lay them by for use.

fixed alcali was dropt in, the volatile putrid alcali immediately began to fly off, and struck the nose with the peculiar smell, as strong as at first.

So that here are all the plain and distinguishing characters of the volatile alcali.

EXPERIMENT 29.

WITH regard to the putrid bile, the *fætor* here is not at all like, nor indeed so pungent or offensive, as the stench of putrid flesh, or putrid blood; having a greasy smell, not unlike stinking olive oil.

PUTRID bile (it was ox-gall that was tried) shews no sign of alcali; it neither effervesceeth with acids, nor does it change the colour of the blue juices; neither does it throw down any precipitate from the solution of the corrosive sublimate.

EXPERIMENT 30.

Two ounces of this putrid bile, being distilled by a gentle heat, and two or three drachms of a transparent liquor having come over, the receiver was taken off, and the produce found to be a volatile spirit, with a peculiar fetid smell, and a considerable degree of pungency; this smell dif-

fers from that of the putrid bile itself, but approacheth nearly to that of the spirit obtained from the putrid blood, though not so pungent.

BUT this spirit made no effervescence with acids; and when mixed with the solution of the sublimate, it threw down but little precipitate, even less than fresh urine did, when mixed with the same solution; neither did it turn the blue juice to a green colour; so that here there were scarce any signs of an alcali: The only circumstance wherein it manifested the alkaline nature, was when saturated with spirit of vitriol; for when its pungency and *factor* were destroyed, by the power of the acid, upon adding the fixed alcali, the peculiar smell of the biliose spirit immediately returned.

It being summer when I was engaged in the above-mentioned experiments, I could not conveniently get any *human bile*, but when winter came on, and the dissections began at the anatomical theatre, I seized the opportunity of collecting a quantity of that fluid; and having suffered it to remain in a corked phial for two months, I then made the following trials.

E X-

EXPERIMENT 31

1. I poured strong spirit of vitriol on some of the putrid bile, but found it raise no ebullition.

HAVING put an ounce of the putrid bile into a little retort, and placed it in a lamp furnace, I drew off about two drachms of a transparent liquor, with a considerable degree of pungency, and a fetid disagreeable smell, like the spirit obtained from the ox-gall.

2. Some of this spirit being dropt into syrup of violets, immediately changed the bluish colour of the syrup into a pale green.

3. When dropt into a solution of corrosive sublimate, it instantly threw down a *white* precipitate.

4. And when dropt into a dilute solution of blue vitriol, it caused the solution to grow turbid, and heightened the blue colour.

5. And yet, notwithstanding all these strong tokens of the *alkaline* nature, the effervescence was but very obscure when strong spirit of vitriol was poured on the biliose spirit.

EXPERIMENT 32.

THE putrid liquor which lay about rotten flesh changed the colour of the blue juices to a dark green. It occasioned a small precipitation when added to the solution of corrosive sublimate, but it did not effervesce with the acid, until air was transferred into it, from a mixture of acid and alkali: this method of treatment, not only made it effervesce, but also destroyed much of the putrid *fætor*.

EXPERIMENT 33.

WHEN the *fætor* of this putrid liquor was destroyed, by pouring vinegar upon it, it returned immediately, on the addition of spirit of *sal ammoniac*.

EXPERIMENT 34.

THE same thing happened when the *fætor* was destroyed by the pouring of weak spirit of vitriol on the same putrid liquor, and afterwards dropping in *lixivium tartari**.

* The acid spirit must here be pretty much diluted, otherwise it will raise a more disagreeable *fætor*, instead of conquering the original putrid stench.

AND thus we find, that as the *fixed alkali* is strong enough to dispossess the *volatile*, so both of them have power to expel the *simple putrid alkali*.

FOR, upon the whole, we may safely join with *Neuman*, in saying, that as soon as an animal substance begins to putrefy, it begins to discover an alkaline quality; and this volatile matter, now produced in it, may be separated by distillation in a very gentle warmth.

WHEN I made the experiments on the putrid blood, related in No. 26 and 27, I had not observed Dr. *Lewis's* note on the above recited passage in *Neuman*: and therefore was greatly surprized to find that very ingenious gentleman declare, "That this general doctrine of the chemists did not appear to be strictly just; and that they seemed to have been mis-led by applying to all animal substances what they had found to obtain in one, but what a farther examination shews to obtain in very few, if any besides, at least in any considerable degree."

"PUTRID urine (says he) gives plain marks that it contains a volatile alkali, already generated; but *putrid blood* and

“ *flesh* are not sensibly alkaline, and yield no
 “ *alkali* on distillation, till after the phlegm
 “ has arisen *.”

AFTER reading this note, from so experienced a chemist, I began to call in question the evidence of my own senses; and had almost concluded that, some way or other (though in what I could not possibly guess) the process had been mismanaged.

I THEREFORE determined to repeat it, and that with the utmost caution and exactness.

EXPERIMENT 35.

Two^o quarts of human blood were put into a retort, which being stopped, was suffered to remain five or six weeks, at the end of which time the blood was found highly putrid, a receiver was now luted on, and the fire raised.

THE very first drachm or two of the liquor that came over was immediately poured out in order to examine it.

IT had precisely the same smell of the spirit obtained in the former process; it

* *Neuman's Chemistry.*

effervesced

effervesced with the *acids*, and shewed all the other alkaline properties already mentioned *

SOME gentlemen of knowledge in chemistry were present during the distillation, and were all thoroughly satisfied, that in this matter Dr. *Lewis* himself hath been misled; and, very possibly, in the same way that Sir *John Pringle* formerly was; for since *alcalies resist* putrefaction, it was reasonable to conclude, that putrid animal substances were little, if at all, alkaline.

BUT the principle on which this action of *alkaline salts* depends, has nothing to do, in particular, with *alkali*, being, as will be shewn immediately, *common* to all *saline bodies* whatsoever.

* The volatile alkali obtained from putrid substances is not exactly similar to that obtained by violent heat from animal substances not putrid.

It differs remarkably in the flavour, which is nauseous and disagreeable, is not so pungent, and is much weaker, than the common volatile alkali; since this last, as we have just now seen, is capable of dispossessing the putrid alkali, and of driving it off from any body to which it hath been united.

afforded with the acids, and showed all the other alkaline properties already mentioned.

Some gentleness of touch was in the

mixture were present during the distilla-

tion, and were all thoroughly exhausted,

than in this manner Dr. Lewis himself has

been misled, and very possibly in the

same way that Sir John Pringle formerly

was; for since chemical rectification is

was reasonable to conclude, that putting

animal substances were little, if at all, af-

fecting.

But the principle on which this action

of alkalies falls depends, has nothing to

do, in particular, with alkali, being, as

will be shown immediately, common to all

alkaline bodies whatever.

Let us now consider the nature of the

volatile gases obtained from putrid substances

is not exactly similar to that obtained by violent heat

ESSAY III.

ON THE
RESPECTIVE POWERS

MANNER OF ACTING,

Of the different Kinds of

ANTISEPTICS.

Although the arguing from experiments and observations by induction, be no demonstration of general conclusions, yet it is the best way of arguing which the nature of things admits of; and may be looked upon as so much the stronger, by how much the induction is more general.

NEWTON.

ESSAY III.

ON THE

RESPECTIVE POWERS, and MANNER of ACTING, of the different Kinds of ANTISEPTICS.

IT was never imagined, until Sir *John Pringle* shewed it, that the *Antiseptic Power* is so extensive; but it appears from the experiments made by that very judicious and learned physician, that *salts of every kind*, whether *acid, alkaline, or neutral, fixed or volatile*, as well as the *astringent and gummy-resinous* part of vegetables, all of them resist, and most of them correct putrefaction; and he pursued this branch of enquiry so far as to enable him to form a table, shewing the comparative antiseptic forces of the several substances.

HIS being so very particular on this head rendered it unnecessary to repeat the experi-

experiments, with regard to all these different substances; but as I had got into the habit of experimenting, and found great satisfaction from this method of acquiring knowledge, I resolved to try some of them; and accordingly began with the *acids*, which, from ancient prescription, claim the right of being placed at the head of this class.

EXPERIMENT I.

HAVING diluted the *acids* of *vitriol*, of *sea-salt*, and of *tartar*, together with *vinegar*, and the *juice of lemons*, all, as nearly as I could judge, to the same degree of weakness, leaving them just so strong as to be fairly sensible to the taste, as to change the blue juices into red, and to effervesce plainly, upon the addition of an alkali; I then put some ounces of each into *five* phials, and in every one of them immersed a little bit of fresh mutton; and a sixth phial, with nothing but water and a bit of mutton, served as a standard.

THEY were all placed in a moderate degree of heat (on the top of the furnace, along with the fermenting mixtures of the second

Table III. Acids diluted tried as ANTISEPTICS.					
ACID-S.	AFTER STANDING				4 Days.
	24 Hours.	48 Hours.	3 Days.		
(1) Of Virriol.	Sweet.	Sweet.	Sweet.		Sweet.
(2) Of Sea-salt.	Sweet.	Sweet.	Sweet.		Sweet.
(3) Of Tartar.	Sweet.	Sweet.	Beginning to putrify.		Putrid; thrown out.
(4) Of Vinegar.	Sweet.	Sweet, and much swelled.	Sweet.		Sweet.
(5) Of Lemons.	Sweet.	Sweet, and much swelled.	Sweet.		Sweet.
(6) Water, as a Standard.	Smell grown offensive.	Very fetid.	Putrid, and fœt.		

second table) and suffered to remain for four days.

It appears by the foregoing table (the 3d) that they were all, excepting the one in the *acid* of *tartar*, and the standard, sweet at the end of four days. I hung up all the sweet pieces in the open air, where they soon became dry, and remained sweet.

Thus it appears that acids, even when greatly lowered, have a strong degree of power to resist putrefaction.

EXPERIMENT 2.

ALONG with this parcel of *acids* I tried the *fixed* and *volatile alcalies*, diluted to the same low degree; but though the *volatile alcali* preserved the piece of mutton immersed in it as well as any of the *acids*, yet the *lixivium tartari* did not keep its sweetness much longer than the simple water which served as a standard.

I RESOLVED, therefore, to try the *alcalies*, without lowering them so much; and, at the same time, was desirous of seeing what share of *antiseptic power* was possessed by a *neutral* mixture.

EX-

EXPERIMENT 3.

FIVE bits of fresh mutton were put into as many phials, with, 1, *lixivium tartari*; 2, *spirit. cornu cervi per se*; 3, *spirit. salis ammoniaci cum calce viva*; 4, *spiritus mindereri*; and, 5, *water*, as a standard.

THE four first were all diluted with water, in the proportion of four to one; and all were left in the common temperature of the air,

THE phials were examined every day, for eight days; and all of them, the standard excepted, which grew putrid in three days, found sweet; the pieces of mutton in the *alkalies*, grew soft and white, like fresh fish, but the one in the *spiritus mindereri* always preserved the natural redness of the flesh.

I now left off examining them every day, and having laid the phials aside for three weeks, found all the bits of mutton as sweet as they were on the first day.

THE power of the saline bodies was also tried, in another manner.

E X P E R I M E N T 4.

I PUT four pieces of fresh mutton into as many cups, and poured on them severally, 1, *weak spirit of vitriol*; 2, *spirit of hartshorn*; 3, *lixivium tartari*; and, 4, a *neutral mixture of fixed alkali and vitriolic acid*; and having suffered them all to remain about ten minutes, by which time they appeared to be thoroughly soaked and penetrated, I then threw them all into glasses with water, and set them by, in the common temperature of the air. The following table, No. 4, shews how long each of them preserved their sweetness.

THUS the power of *salts in general*, to keep off putrefaction, was most satisfactorily proved; and as this power belongs to *saline bodies in general*, it certainly must depend on some property which is *common to them all as salts*, since we plainly see that *acid and alkali* have nothing to do here.

WITH regard to *astringents*, Sir John Pringle's experiments shew them to be possessed of a very great degree of antiseptic virtue; for *allum, galls, green tea, and red roses*, were all found to resist putrefaction, with a power greatly superior to *sea-salt*.

AND

Table IV. SALINE BODIES as Opposers of Putrefaction.

Spirit of Vitriol.	Spirit of Hartshorn.	Lixivium Tartari.	Neutral Mixture.	Water, as a standard.
Remained sweet 28 Days.	Remained sweet 8 Days.	Remained sweet 4 Days.	Remained sweet 14 Days.	Was putrid in 36 Hours.

AND the gum-resins, such as *myrrh*, *asa fœtida*, *aloes*, and *terra japonica*, together with decoctions of such vegetable substances as abound in *gummy-resinous* parts, *virginian snake-root*, *pepper*, *ginger*, *saffron*, *contrayerva root*, *sage*, *valerian root*, and *rhubarb*, with *mint*, *angelica*, *fenna*, and *common wormwood*, all of them shewed great antiseptic power; but none of them came up to *camphire*, in this respect, which Sir *John Pringle* thinks may be allowed to keep off putrefaction, with a power *three hundred times greater than sea salt*.

MANY of the common esculent vegetables, *horse-radish*, *mustard*, *carrots*, *turnips*, *garlic*, *onions*, *celery*, *cabbage*, and *colewort*, were likewise found to keep back putrefaction*.

BUT as to the antiseptic power of *lime-*

* Most of these, beside a great variety of other things, have been lately tried in *France*, with respect to their power as Antiseptics, and the result of the whole published under the title of *Essai pour servir a l'Histoire de la Putrefaction*. Paris 1766.

It does not appear who is the author, but the experiments, which are very numerous (not much short of 300) have been made with surprising patience and accuracy.

water,

water, there appeared to be a kind of dispute,—and therefore,—

(EXPERIMENT 5.)

IN order to satisfy myself in regard to this matter, I put a bit of fresh mutton, of two drachms weight, into an open glass, containing some ounces of stone *lime-water**: It was left there for a fortnight, and at the end of that time was found perfectly sweet; it had indeed grown quite tender, and when it was cut into, and some *spirit of vitriol* dropt on it, an effervescence ensued, from the particles of the *quick-lime*, which had penetrated the substance of the flesh, and *there* being saturated with the *fixed air*, were now returned to their original state of a *calcareous earth*.

THIS circumstance of the effervescence, may possibly lead us to the *true theory* of the *antiseptic power*, and shew us on what it immediately depends.

WE have seen, by the 16th experiment of the preceding essay, that putrefaction ensues in consequence of the *escape* of the

* It appears that Sir *John Pringle* made his experiments with chalk, and oyster-shell *lime-water*.

fixed air; therefore, whatsoever hath the power to *restrain* the flight of this element, or *hinder* the *intestine motion*, must of course *prevent* putrefaction.

CALCAREOUS *earths*, in their native state, have a strong *affinity* with *fixed air*, and we have seen, that upon this account, when they lie in contact with an animal substance, they attract some of this element, and thereby accelerate putrefaction: For here they *cannot penetrate* the substance of the putrescent body; they only *surround* it: But when these earths are calcined, and converted into *quick-lime*, then a certain portion of them is rendered *soluble* in *water*; the earthy particles, thus minutely divided, are *now* capable of *pervading* the soft texture of animal and vegetable bodies; where, as hath been just now seen, they immediately join themselves to the *fixed air* of those bodies: So long therefore, as the particles of *lime* remain in this situation, so long will the *fixed air* remain in a non-elastic state, and so long will the intestine motion, and that particular combination of the insensible parts which constitutes putrefaction, be kept at a distance.

IF *saline* bodies have a strong *affinity* with *fixed air*, which seems highly probable, it is easy to account for their antiseptic virtue; for they are all of them capable of such extremely minute division, that their particles can most easily penetrate into any animal, or vegetable body, and *there*, immediately join themselves to the *fixed air* of those bodies, *where* remaining, they will, like the *lime*, when divided and dissolved in water, keep back putrefaction by *preventing the intestine motion*, and *restraining the flight of the fixed air*.

IF we attend to all the methods that are used to prevent bodies from putrefaction and decay, we shall find that they mostly tend to this single point: Timber is covered over with paint, or some such unctuous and tenacious matter; fruit*, and other green vegetables, are preserved the year round, by slightly scalding them (which thickens their external coats, naturally formed to prevent the escape of their air) and then drying them well, and putting them into bottles closely stopped; flesh meat of all sorts is preserved on the same

* Such as apples and gooseberries for baking.

principle, and may be kept for many months without much seasoning, provided it be well roasted or baked, and then covered over with lard, butter, or suet; and eggs, it is well known, will remain fresh for a long time, if their shells be coated over with melted suet, or the like tenacious substance.

ANIMAL fluids, likewise, if the air be not suffered to escape from them, remain for a great while, without growing putrid; surgeons often meet with large collections of extravasated blood, or serum, which, after lying for years, in their own firm and compact cysts, do not betray any thing putrid on their being first let out; but in a very short time after the opening is made, and there is a way for the air to fly off, the discharge grows intolerably fetid; and they also find, where wounds are made in fleshy parts by simple incision, and are so circumstanced as to lay them under no necessity for frequent dressing, that, when carefully kept covered, and the escape of the air prevented, they heal in a very short time, without any sign of suppuration, which is a certain degree of putrefaction.

THE

THE various *non-astringent* vegetables which Sir John Pringle tried, and which he found to retard putrefaction, must have done so in consequence of their property to raise a fermentation when mixed with any animal substance; and as to the principle on which *astringents* become *antiseptics*, it is easily comprehended.

THE action of *astringents* consists in their corrugating, or crisping up the animal fibres, whence the solid particles of these fibres are brought to a nearer approach, and the power of their cohesion considerably increased; consequently, the substance of the body, so acted upon, must become more firm, and compact, and this of course must hinder the *intestine motion*, without which there can be no putrefaction.

ALL bodies possessed of this *astringent* power, with regard to the *fibres*, and which, at the same time, have a strong *affinity* with *water*, must be *antiseptics* on a double account; accordingly, we see whence it arises, that *ardent spirits*, and the strong *mineral-acids*, especially the *vitriolic*, resist putrefaction so very powerfully: For these not only absorb the *water* from the putrescent substance, but likewise

wise crisp up its *fibres*, and thereby render it so hard and durable, that no change of combination will take place for many years*.

So

* Dr. *Petit* made a number of experiments in the year 1732, with a view to determine the different degrees of astringent power in such substances as are usually applied to stop bleedings, and he observed at the same time their respective antiseptic powers. His method was to take little pieces of fresh mutton of the exact weight of two drachms, and having covered them over with astringent substances reduced to powder, he left them in that situation for four days. At the end of every twenty-four hours, the bits of mutton were taken out, freed from the powders, and accurately weighed; according as he found the weight to diminish, he calculated the strength of the astringent; for his way of accounting for the action of astringents, is, that they absorb the moisture from the fleshy substances to which they are applied.—“ Ils resserrent les orifices auxquelles
 “ ils s'appliquent parce qu'ils en absorbent l'humidité,
 “ ce qui étant fait, les parois des vaisseaux diminuees
 “ de volume se rapprochent par leur ressort naturel, &
 “ peuvent se rapprocher au point de se coller ensemble
 “ & de fermer le vaisseau.”

His theory, in relation to the Antiseptic Power of Astringents, is as follows: “ La corruption vient de la
 “ desunion des principes qui formoient les molecules de
 “ la chair ou ses parties integrantes; l'humidité favorise
 “ cette desunion, le desséchment & le resserrement y est
 “ contraire. De la suit manifestement, qu'un bon
 “ Astringent.”

So far in relation to the virtue of things opposing putrefaction; let us now proceed to consider those which have the power of restoring sweetness to substances actually putrid.

EXPERIMENT 6.

HAVING put a number of small pieces of mutton into a phial with water, and placed it in a moderate degree of heat, in order to make them putrefy the sooner, I found them, after standing four days, sufficiently soft and putrid; I then put *five of* these bits of putrid mutton into as many cups, and poured, on the 1st, *spirit of vitriol*; on the 2d, *spirit of sea-salt*; on the 3d, *vinegar*; and on the 4th, *fresh lemon juice*; the 5th cup contained only water, and was left as a standard, by which the others were to be compared*.

To have a synoptical view of the changes from day to day, I formed the following

“Astringent doit laisser la chair, s’il est possible, sans corruption & sans mauvais odeur.” *Hist. & Mem. de l’Acad. R. des Sciences*, 1732.

* The mineral acids in this experiment were diluted so as to reduce them, as nearly as could be judged, to the strength of the vinegar that was used.

table,

table No. 5, and at the expiration of twenty-four hours, found the several appearances exactly as set down in the first column thereof; after forty-eight hours, the appearances were agreeable to the second column of the table; at the end of three days, things stood as in the third; and after four days, the several bits of the mutton were found in the condition expressed in the fourth column.

BEING thus satisfied of the power of *acids* to *correct* putrefaction, I threw out all the pieces of the mutton but the 5th, which had served for a standard; reserving it for another experiment.

THUS it appears, that the *vitriolic* acid has a more powerful antiseptic virtue than the *marine*; and that both of them shew an *astringent* quality, by their hardening animal fibres, though in a different degree; and the effect of the *vegetable* acids, in so remarkably softening and relaxing the solid fibres, gives room to expect great things from their power as resolvers, when outwardly applied.

SINCE *acids* both *resist* and *correct* putrefaction, it was very reasonable to expect that all putrid diseases should yield to them, when

Table V. Acids tried as Correctors of Putrefaction.

Acids of	24 Hours.	48 Hours.	3 Days.	4 Days.
Vitriol.	The bit of putrid flesh was found hard, shrivelled up, and almost sweet.	Entirely sweet; very much shrivelled and hardened.	As on the day before.	As on the day before.
Sea-salt.	Not so much hardened as in the Sp. Vitrioli, nor so much sweetened.	More sweet than on the preceding day, but not entirely sweet.	No change since yesterday.	Putrid smell returned.
Vinegar.	Softened; greatly swelled, and entirely sweet.	No change since yesterday.	No change.	Grown livid, but still soft and sweet.
Lemon-juice.	Softened; greatly swelled, and entirely sweet.	No change since yesterday.	No change.	Grown perfectly white, but quite sweet.

when given in the way of medicine; but *experience*, the only thing on which the *practice* of *physic* must always rest, abundantly shews that their power in this respect is pretty much limited; and that where the putrid matter to be corrected lies beyond the first passages, *acids* are found quite insufficient to conquer it.

E X P E R I M E N T 7.

BUT the *alkaline* salts even exceed the *acids*, in regard to the power of correcting putrefaction; for two small pieces of putrid beef, after lying a night in the *volatile alcali* *, diluted with water, in the proportion of four of the latter to one of the former, were found perfectly free from the putrid stench; but they were so fully charged with the liquors in which they had lain, that not even boiling could destroy the peculiar smell of the *volatile alcali*.

* Both the mild and the caustic alcalies were tried; viz. Spiritus cornu cervi per se, & Spiritus salis ammoniaci cum calce viva.

EXPERIMENT 8.

THE *fixed alkali* likewise sweetens very powerfully: A little bit of putrid beef, from lying twenty-four hours in *lixivium tartari*, diluted with an equal quantity of water, became hard and firm, and was found to have no smell, but that which is peculiar to the *lixivium*.

EXPERIMENT 9.

BUT the *neutral mixture* does not give sweetness: *spiritus mindereri*, if made in such manner as to be *perfectly neutral*, seems to have no power to correct putrefaction; if the *volatile alkali* is allowed to predominate, the mixture will sweeten in proportion; for, as hath been just now related, the *volatile alkali* is very powerful in driving off the putrid stench.

EXPERIMENT 10.

SPIRIT of *vitriol* and *lixivium tartari* being mixed to the point of saturation, and a bit of putrid beef being left in the liquor for twenty-four hours, was found not at all sweetened.

EXPERIMENT 11.

A STRONG decoction was prepared from equal parts, *tormentil root*, *balaustines*, *pomegranate peel*, and *red-roses*, and a bit of putrid beef was immersed in the liquor; the *sator* seemed rather increased than diminished, by lying twenty-four hours in this decoction.

EXPERIMENT 12.

THE same thing happened with *lime-water*, which, notwithstanding it *resists* putrefaction so strongly, appears to have no power to *correct* it.

EXPERIMENT 13.

NEITHER have *ardent spirits* the least power to destroy the putrid stench, any further than as it is, in some degree, obscured by their own peculiar flavour.

EXPERIMENT 14.

STRONG decoctions of the *bark*, and of *valerian*, together with strong infusion of *camomile flowers*, were also tried as sweeteners. After suffering three small pieces of putrid flesh to lie thirty-six hours in these

these liquors, I could scarcely take upon me to say they were sweetened; the putrid stench indeed was rendered more tolerable, by the smell of the liquors, but did not seem to be much conquered.

For unless the decoctions be frequently renewed, as was done by Sir John Pringle, so as by repeated affusions the viscid particles of the gum-gum may be applied in such quantity as will wholly entangle and fix the volatile particles of the putrid alkali, the effect is but small; excepting the putrid body is allowed to remain long enough in the decoction or infusion for a fermentation to begin, which will indeed effectually change the state of the mixture, and produce such a new combination as will maintain its sweetness for a considerable length of time.

THIS power of fermenting mixtures to restore sweetness was discovered by Sir John Pringle; but as I have made several experiments in relation thereto, I shall here lay them before the reader.

EXPERIMENT 15.

WHILE the 6th experiment, with regard to the power of acids in correcting putrefaction,

faction, was going on, I one evening took a bit of the mutton out of the *store phial*, which was grown, by that time, exceedingly soft and putrid, and having fastened it to a thread, immersed it, at eight o'clock, in a vat of *melasses wash*, at the distiller's, then in a degree of fermentation, rather upon the decline. Next day, at noon, I took it out, and having washed it in water, in order to free it from the smell of the liquor in which it had been lying, found it perfectly sweet and firm.

As this piece had been rendered so entirely sweet and firm, and, to all appearance, sound, for it looked like a bit of meat that had been slightly fried, I conjectured that it might not be necessary for it to lye so long as sixteen hours; I therefore obtained a gallon of the wash, from my friend the distiller, that I might examine the progress at home, and at my leisure.

EXPERIMENT 16.

I PLUNGED into this gallon of fermenting liquor the very identical piece of mutton that had served as a standard in the sixth experiment on the acids; and which, for several days, was

was grown so soft that I was obliged to tie it round with a piece of thread (for, when the thread was passed through it, the flesh was so tender that it would not hold) and so extremely putrid that the stench was intolerable.

IN *one* hour the putrid smell was much abated, and at the end of *five* entirely gone, the meat being now firm, and perfectly sweet; it was hung up in the open air, where it soon became dry, and remained sweet ever after.

EXPERIMENT 17.

IN order to see whether this change depended on the liquor, or on the vapour, I suspended a thin bit of putrid mutton, from the *store phial*, in the mouth of the vessel wherein the *wash* was fermenting, but so as not to touch the liquor, and left it there during the night; in the morning it was found plumped up, sweet, and firm.

THIS experiment I frequently repeated, and always with success; but whoever chuses to try it, must take care that the pieces of putrid meat be cut thin, so as the vapour may have power to pervade them,

otherwise the sweetness will not be completely restored; whereas, when the experiment is made with the liquor, and the pieces of putrid flesh are suffered to lie soaking in it, they may then be cut of any size that the party pleases; for if time be given, the subtilis gas will penetrate, and produce its effect.

EXPERIMENT 18.

EVEN acids will sweeten pretty large pieces; two bits of putrid beef, of an ounce weight, were left severally in *distilled vinegar*, and in *melizet wash*, just as it had done working.

The first was found very much, though not entirely, sweetened, after lying twenty-four hours; but the second was rendered perfectly sweet. In order to see if they were thoroughly penetrated, and sweetened to the heart, I boiled both the pieces, and was surprized to see the one which had lain in the *acid* go all to pieces in the boiling, which I thought the more odd, as it had been rendered hard and firm; an effect wherein the *distilled vinegar* differs widely from that which is *not distilled*. This dissolution I ascribed to the peculiar *dissolvent* quality

quality of the vinegar, and did not believe, until I tried it, that a *mineral acid* would produce the same effect.

EXPERIMENT 19.

BUT an ounce of putrid beef, after lying twenty-four hours in *dilute spirit of vitriol*, and coming out perfectly hard, sweet, and contracted, on being boiled, fell all to pieces, exactly as did the one which had lain in the distilled vinegar; and when rubbed between the fingers, it melted away like so much wet paste. To be certain that nothing of this was owing to too much boiling, I put a little bit of beef, of a drachm weight, that had been sweetened by the *volatile alkali*, into the vessel along with it, and suffered it to remain the whole time of the boiling; but it came out white and firm, and, as hath been mentioned already, strong of the *volatile alkali*.

FOR the *alkalies* cannot be said, with propriety, to restore sweetness; they only drive off a *weaker alkali*: As the *fixed alkali* can dispossess the *volatile*, so both of them have the power to drive off the *simple putrid alkali*; and thus the putrid sub-

stance becomes the *basis* of a *stronger*, instead of a *weaker*, *alkali* *.

* The manner in which *acids* sweeten putrid flesh seems also pretty plain; for their action appears to consist in *saturating* and *fixing* the *putrid alkali*, and by thus destroying its *volatility*, they hinder the putrid *fætor* from flying off, and striking the organs of smell; but at the same time that *acids* do this, they *dissolve* the *elementary earth*, and thus destroy the texture of that substance whose soundness they were supposed to restore. Whereas, the peculiar excellence of the fermenting liquors is, to restore sweetness to the fluids, and firmness to the solids.

EXPERIMENT 20.

Two pieces of linen rag were dipt in the putrid liquor of the *store phial*; one was suspended over the *wash* in fermentation, and the other was hung up in the open air. In two hours the one exposed to the *vapour* became almost sweet; the other remaining as offensive as at first; and

* See the 28th, 30th, 33d, and 34th experiments of the preceding essay.

in six hours, the first piece of rag had no smell but that of the vapour; while the other, though now grown dry, still strongly retained the putrid stench.

As sugar is an antiseptic, in consequence of its saline nature, I did not know but somewhat of the virtue of the *molasses wash* might depend on this circumstance.

In order to determine this, I immersed one small bit of putrid flesh in a mixture of bread and mutton, with lemon-juice, and suspended another in the neck of a phial containing a fermenting mixture, with spinage; and found after eight hours that both of them had lost the putrid stench, and had now no other smell than that of the mixtures; which, as hath been elsewhere observed, was sweetish, and not unlike fenugreek seed. The like experiment was tried with another fermenting mixture, as the reader will find by turning back to the 45th page.

SIR John Pringle seems to think, that the putrid smell in these mixtures is destroyed by the *acid* which is produced in the course of the fermentation. Relying on his authority, I was for some time of the same opinion, and looked on the *subtile*

gas as somewhat of the nature of a *volatile acid*; for I had *then* the *ideas* of *acid* and *antiseptic* strongly connected together in my mind: but, upon enquiry, this notion was found to be void of foundation.

EXPERIMENT 21.

FOR one piece of linen rag dipped in *lixivium tartari*, and another tinged *blue* by the scrapings of *radishes*, were exposed for eight and forty hours to the vapour arising from a large vat full of molasses wash, in high fermentation; yet the first was not at all saturated, nor the last, in any, even the slightest, degree changed red.

AND in all the fermenting mixtures that I tried, none of them became sour, excepting one (No. 6, table 1) for several days after the first stage of the fermentation had ceased*.

EX-

* In order to see how long this kind of mixtures would preserve their sweetness, I reserved three of the 14th experiment of the second essay; to wit, those with the barley, the rice, and the oats.

Into the phial with the barley I put about half an inch of a thread which had been dipped in a putrid animal

EXPERIMENT 22.

Two drachms of the *cortex* in powder, and half an ounce of *saliva*, were added to

mal fluid; into the one with the rice I poured a tea-spoonful of vinegar; the third, with the oats, was left without any addition.

All the three mixtures were now at rest, having run through their first stage, and being every one perfectly sweet, they were left in the common temperature of the air; the phials not closely stoped. (This was in the month of *July*.)

For three weeks, no alteration was perceivable in any of them; but at the end of that time, the mixture into which the putrid ferment had been put began the intestine motion, which continued, in a gentle degree, for seven or eight days before the mixture became fully putrid.

The phial into which the vinegar had been thrown, began at the three weeks end, to shew some small signs of intestine motion; a thick, white scum formed on the surface, and it did not grow putrid until it had stood, in all, six weeks.

The third mixture, to which nothing had been added, remained quite at rest, without shewing any signs of motion for two months; then it was found to have grown sour, and had contracted acidity sufficient to curdle milk, and to raise an ebullition when some salt of hartshorn was thrown into the phial.

I now corked the phial, and set it aside for three months; and then, having distilled the mixture by a

a mixture of *ox-gall* and *water*, which was grown *putrid*, for it had been used as a standard to two mixtures of *gall* and *testacea*.

UPON the first mixture, the *fætor* increased greatly, and the bark seemed to act on the putrid bile in a manner not unlike the action of *lime*, or *fixed alcali*, when mixed with *crude sal ammoniac*, in order to drive off the *volatile alcali*.

THE mixture was now laid by for twenty-four hours, at the expiration of which I found the putrid smell much abated, and a fermentation beginning; I now suspended a little bit of putrid flesh in the neck of the phial, and placed it in a moderate degree of heat. When twenty-four hours more were elapsed, I again examined the mixture, which was still in brisk motion, and found that it had entirely lost the *fætor*, having now acquired a new and peculiar smell, which was not only sweet, but agreeable, and different from the original smell either of fresh bile, or of the *cortex*.

very gentle heat, I obtained a *volatile alkaline spirit*, of a peculiar smell, not unlike that obtained from the putrid blood formerly mentioned.

THE

THE bit of putrid flesh was found sweetened; having removed it, I fixed the bended glass tube as described formerly, and, by means thereof, joined a small phial, containing a drachm of *non-effervescent, volatile alkaline spirit*, to the phial which held the fermenting mixture: They were left in conjunction for twenty-four hours, and when separated, some *spirit of vitriol* being dropped into the small phial, raised a smart ebullition.

IT has been shewn in former experiments, how readily the *bark* runs into fermentation out of the body, and there is great reason to expect that it will be still more prone to ferment in the body, when opened by the digestive fluids; and the present experiment shews plainly, that when opened by fermentation, the *cortex*, like the *melasses*, and other things that were tried, gives out some subtile matter, which hath the power of restoring sweetness to putrid animal substances: Is it not agreeable then to reason, as well as experiment, to account for some share of its *antiseptic* virtue upon this principle?

IF we attend to the nature of the diseases wherein the bark is found most useful; and,

and, on the other hand, remark those cases wherein it either does harm, or proves of no effect, we shall find some ground for establishing this *hypothesis*.

FIRST, the *cortex* is of the highest service in *gangrenes*, where the vessels are relaxed, and the blood dissolved; 2, in wounds and ulcers, where the solids and fluids are in the same weak and dissolved state; 3, in the low state of malignant fevers, and small-pox, where the humours are evidently putrid; 4, in intermittent fevers, where almost every symptom betrays evident marks of a putrefactive acrimony.

In these last it seems to be the most plausible opinion, that the morbid matter is lodged originally in the flexure of the duodenum; here the *cortex* comes into immediate contact with the putrefactive *colluvies*, and *presently* * running into fermentation, soon throws off a quantity of the subtile vapour, sufficient to saturate the acrimonious matter; which being thus rendered mild and sweet, the febrile commotion, which would have ensued had this

* The putrid matter will encrease the tendency to fermentation.

irritating cause not been removed or corrected, is now prevented.

IN this case, we have supposed the general mass of fluids to be untainted; but, even in cases where the putrefactive acrimony has made further advances, and has actually taken place in the constitution, if the medicine be continued, and given in large quantities, its salutary effects will presently appear, and will shew that the *antiseptic vapour* can reach the blood, and there restore its consistence, and correct its sharpness.

BUT this valuable drug has another great advantage. Beside its readiness to ferment, and being able to yield a large proportion of the *antiseptic vapour*, it hath also a remarkable power of bracing up and strengthening the vascular system; thus enabling the powers of the body to concoct the morbid matter, and expel it by the proper excretories: For it is observable, that, after a liberal use of it, profuse evacuations of urine and sweat often ensue, and sometimes beneficial discharges by stool; then, when the offending matter is so thrown off or corrected, the astringent quality of the bark braced up and strengthens the solid fibres,

fibres, which had been relaxed and weakened by the putrefactive acrimony.

BUT in diseases where there is an inflammatory tendency, where the vessels are full, the fibres tense and rigid, and the blood thick and fizy, then is the bark hurtful and dangerous; because, it throws *much air*, and *no water*, into the blood, and consequently must highly increase the morbid disposition of the fluids, while, at the same time, its astringent virtue must add to the *tension* of the *living solids*.

FOR this *subtile antiseptic vapour* appears to consist chiefly, if not altogether, of the *fixed air* * of the fermenting substances; since

* This, I find, is not admitted by Dr. Cullen, the celebrated professor (late of chemistry, but now of the theory of medicine) at *Edinburgh*; for he teaches (as I am informed) that there is a volatile acid which flies off from fermenting and effervescent mixtures along with the aerial principle, and that it is this acid which destroys the putrid fœtor, while the air restores firmness to the pieces of rotten flesh. This *volatile vegetable acid* is said to bear the same relation to the *fixed vegetable acids*, that the *volatile vitriolic* does to the *fixed vitriolic*.

But it seems that this volatile vegetable acid has not the power to change the blue juices to a red colour, nor to saturate the alkaline salts; therefore, the 21st experiment

since I have found, by experiment, that as the *fixed air* thrown off by *effervescence* agrees with the *gas sylvestre*, in *suffocating animals*, so does it agree with the same gas in the property of *restoring sweetness*.

EXPERIMENT 23.

A SMALL piece of putrid beef, taken immediately from the liquor in which it lay, was put into a cup with some *lixivium tartari*, and on it was poured by degrees, a sufficient quantity of *spirit of vitriol*.

THE moment the saturation was complete, the bit of beef was taken out, and found to have almost entirely lost the putrid *fætor*; what smell it now had, was rather to be termed musty than putrid; on washing it in clean water, this musty smell went off, and a very little of the putrid was again to be perceived.

EXPERIMENT 24.

ANOTHER bit of the same putrid beef was put into a cup, with some *salt* of

experiment of this essay is by no means conclusive, and has led me into an error, in ascribing the power of restoring sweetness chiefly to the aerial principle.

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hartshorn, and on them vinegar was poured, to the point of saturation: immediately on the cessation of the ebullition, the piece of flesh was taken out and found to have entirely lost the *sator*, having now no smell but that of the neutral mixture, which is not unlike the smell of burnt horn; but upon washing the beef, this smell went off in great measure, and not the least of the putrid stench was to be perceived.

BOTH these pieces were boiled, and both came out perfectly firm; the last piece, upon being cut into, was found sweet to the very heart; but the other was found not to have been so thoroughly pervaded, as it discovered a little of the putrid smell on being divided.

EXPERIMENT 25.

A BIT of putrid flesh, of about a drachm, was put into the phial C, as in figure 2, which previously had a drachm or two of *sal cornu cervi* thrown into it, the glass tube was fixed closely into the neck of the phial, and the other extremity of the tube inserted into a small phial, with half a drachm of the putrid liquor that lay about the

the

the rotten flesh; vinegar was now poured through the funnel, to raise an ebullition. When the salt was all dissolved, and the effervescence at an end, the phials were separated; the bit of beef was now found sweet, and the putrid liquor, which before shewed no signs of ebullition upon dropping an acid into it, *now* effervesced plainly, on the addition of *spirit of vitriol*; and it had besides lost much of the putrid *fætor*.

AND thus we see, that fermenting and effervescent mixtures are the most powerful of all known *antiseptics*.

SOME share of this power remains in liquors after they have run through their first stage of fermentation, which is different in different liquors; as may be seen in the following table (No. 6) and seems to depend on the quantity of the subtile vapour which is left in the liquor, since those that are most sparkling and brisk, are found to possess the greatest share of antiseptic power*.

THE

* “ When, by fermentation, the constituent parts
“ of a vegetable are separated, part of the air flies off
“ into an elastic state; part unites with the salt, oil,
“ and earth, which constitute the tartar; the remain-

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“ der,

Table VI. COMMON FERMENTED LIQUORS tried as Sweeteners of Purid Flesh.

Claret.	Lisbon White Wine.	English Cyder, (bottled.)	Common Dublin Ale.	Melasses Waste, (newly fermented.)	Sugar and Water (not fermented.)
At the end of 30 hours, the bit of putrid meat was found perfectly sweet and firm.	At the end of 12 hours, the bit of meat was found perfectly sweet.	At the end of 12 hours, the bit of meat was found quite sweet.	After 24 hours, not at all sweetened. N. B. This kind of ale is but of the breaker sort and generally not very brisk.	In 12 hours, the bit of putrid meat became sweet. This perfectly sweet.	After 24 hours, not at all sweetened.

THE *fixed air*, when transferred from a sound body into one that is putrid, appears to restore to that body the *principle* that hath been destroyed or lost †.

BUT here it may be demanded, what can these experiments prove with regard to the restoration of putrid fluids, in a living body: is it possible to saturate these humours with such a quantity of air as will be sufficient to *correct* their *sharpness*, *restore* their *consistence*, and *bring back* their *sweetness*?

To this it may with safety be replied, that it is not only possible, but that it is, perhaps, the only way by which this change can be produced.

FOR we have seen that there is a deception, in regard to both *acids* and *alkalies*, when we suppose them to restore sweetness to a putrid animal substance; that the *first*,

“der, which continues in the fermented liquor, is
“there, some of it in a fixed, and some of it in an
“elastic state.” *Hales*, vol. i. p. 300.

† The manner of acting of air, when transferred into a body whose texture is broken and dissolved, will be better comprehended from some experiments hereafter to be mentioned in the 5th Essay; the thing being, in some degree, rendered visible.

so far from giving soundness to such kind of substances, do in reality destroy their texture; and that the *second* only change the nature, but do not restore the original sweetness.

BUT *acids*, we have likewise seen, are *naturalized**, during the alimentary fermentation, and therefore they cannot act as acids, by saturating any thing of the *alcalious* kind that they meet with in their course of circulation. The power of *acids*, therefore, is confined, and we are not to expect, that they are to pervade the minute branches of the vascular system, when indeed, it is evident, that they *ought not* to be allowed to pass into the *blood* in their *acid form*, since it is plain, that, from their dissolvent nature, the body must be destroyed, and its most solid parts melted down to a jelly, if *naked acids* were to be received into the general mass of fluids †: Their action, therefore, cannot extend be-

* See the 3d and 5th experiments of the 2d Essay.

† In those deplorable cases that now and then happen, where all the bones become soft, a manifest acidity hath been discovered in the fluids; a thing seldom observed in other morbid cases. See *Haller. Element. Physiolog.* tom. ii. p. 94.

yond the limits of the alimentary canal, where they may come into contact with, and correct the sharpness of a putrid colluvies. In these cases they may, and actually do, exert very notable powers, as is often experienced, by their preventing sickness and nausea, and restraining vomitings; and by neutralizing, as it may be termed, the putrefactive matter, thus prevent it from carrying into the blood its peculiar destructive quality.

WITH regard to the exhibition of *alkalies*, the point is not yet thoroughly settled. There can be no doubt of their power to resist and correct putrefaction, in *dead bodies*; but whether, upon the presumption of this virtue, they can be given with propriety, as antiseptics, is not so clear.

A VERY eminent and successful practitioner is of opinion, "That the exhibition
 " of volatile alcalious salts to the sick, in
 " putrid diseases, is adding fuel to the
 " fire; for they certainly dissolve or break
 " the globules of the blood, and thence
 " more speedily bring on the general putrefaction." And he relates a singular case, where an uncommon quantity of *salt of hartshorn* being taken by a young gentleman,

tleman, and the use of it continued, “ An
 “ hectic fever ensued, as also vast hæ-
 “ morrhages from the intestines, nose, and
 “ gums; every one of the teeth dropped
 “ out, and the patient could eat nothing
 “ solid; he wasted vastly in his flesh, and
 “ his muscles became as soft and flabby as
 “ those of a new born infant; and broke
 “ out all over his body in pustules, which
 “ itched most intolerably, so that he
 “ scratched himself continually, and tore
 “ his skin with his nails in a very shock-
 “ ing manner; his urine was always
 “ excessively high-coloured, and very
 “ foetid*.”

THE acrimony † in this case however appears to have been what *Gaubius* terms *acre acalescens volatile purum*, which, though a component part, is not to be confounded, or looked on as the same, with the real and genuine putrid acrimony; this seeming to consist, in an over proportion, and irregular combination of the saline and oily particles of the blood; these particles

* *Huxham on the Sore Throat*, p. 67 & 68. See also his *Essay on Fevers*, p. 118, 5th Edition.

† *Vide Gaubii Instit. Path.* sect. 310 & 312.

being

being left at liberty to run into this destructive combination from the want of their bond of union, the fixed air,

ASTRINGENTS, as hath been shewn, prevent putrefaction very powerfully, but we find that they have not the least degree of power to correct it.

BUT putrefactive acrimony first takes place in the *fluids*, and it is on account of *their* indisposition, and the destructive and irregular combination of *their* particles, that the texture of the *solid fibres* is weakened, and their cohesion impaired; therefore, bracing up and strengthening the system of solids, while the mass of fluids continues in the morbid state, can avail nothing; it is beginning the cure where it ought to be concluded.

ASTRINGENTS, therefore, as *antiseptics* can only be of importance in those cases, where, from extreme relaxation and resolution of the solids, the dissolved fluids are suffered to transude, and either form spots of different hues, or run off by actual hæmorrhage; here indeed, the *acid of vitriol* as an *astringent*, not as an *acid* (for *vinegar* would do nothing in this case) is found of

great use, in *gaining time*; either, till the powers of the animal oeconomy correct the morbid disposition of the fluids, or that the same thing is brought about by the virtue of some efficacious *antiseptic*, such as the *cortex*, which is the thing usually joined with the *spirit of vitriol*, and that with the greatest propriety, on account of its own astringent quality, as well as extreme readiness to run into fermentation; which is the circumstance that constitutes a true and genuine antiseptic.

THE physician who gives astringents in these cases, and with these views, acts not unlike a surgeon who secures and ties the blood-vessels that are divided in the beginning of an operation, in order to allow himself sufficient time to finish it with safety and regularity.

THAT the credit which *acids* have gained as *antiseptics*, hath rested much on the success attending their exhibition in the circumstances above-mentioned; and that they really act in these cases as mere *astringents*, may be found from a close attention to the progress of the cure.

LET any one read the very remarkable case in Dr. Huxham's Treatise on Fevers

(p.

(p. 62) and it will plainly appear that the *acid* of the *vitriol* braced up the fibres, checked the transudation of the dissolved blood, and thus obtained a truce until the repeated doses of the *cortex*, "the *rice*, "the *panado*, the *sago*, the *hartshorn-jelly* "well acidulated, and the *toast* out of "claret and red port-wine," generated enough of the *antiseptic vapour* to saturate and correct, in some degree, the putrefactive acrimony, whereby the patient was enabled to get upon his legs, when exercise, and a proper diet, restored him to his perfect health*.

To shew this still further, in a case no less deplorable, I shall give the following, communicated by Dr. *Archer*, physician to *Stevens's Hospital* in *Dublin*.

"*THOMAS BROWN*, a robust country-man, of about twenty-four years of age, was admitted, the first of *February*, 1762, a surgical patient into Dr. *Stevens's Hospital*, for an *Herpes exedens*, which extended from the nape of the neck to the in-

* There is a case in *Sydenham* equally strong in regard to this point; it was communicated by Dr. *Goodall*, and is to be found in the Letter to Dr. *Cole*, concerning the small-pox and hysseric diseases.

terior part of both *scapulae*. After having been purged, on the 5th he was ordered to take ten grains of the blue pill every day, which he did until the 25th; so that in this time he had taken near two hundred grains of *mercury*, without any appearance of salivation*.

“ ON the 26th, he complained of sickness in his stomach, entire loss of appetite, and great weariness; the ulcer had not mended; he was therefore confined to his bed, and ordered to drink plentifully of warm diluting liquors. The 27th, there appeared numerous *petechiae* on his whole body. The 28th, the number of these increased, and appeared livid. The 1st of March, he had an hæmorrhage from the nose, which was attempted to be stopt, by different styptics; but these causing him to sneeze, rather increased the bleeding: The same evening he was ordered a vomit, which he took, and another next morning; by these the bleeding likewise increased.

* This blue pill used in Stevens's hospital, consists of nothing but crude mercury, and as much Venice turpentine as is sufficient to extinguish the quicksilver.

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"THE apothecary of the house (it not being the physicians' visiting day) then ordered him three spoonfuls of the following mixture, to be taken every two hours.

R. *Aq. Mentb. vul. Sim. Tinct. Rosar. cum triplici quant. Sp. Vitriol. aa uncias tres, Tinct. Cort. Peruv. uncias duas, Tinct. Martis in Sp. Salis, Sefunciam, M.*

"THIS, he said, restrained the hæmorrhage; but, on the 3d, blood came away abundantly in his urine.

"HE continued the above mixture until the 4th, when I was desired to see him: I found him greatly exhausted, his pulse quick and weak, frequently spitting black coagulated blood, his urine the colour of blood, his body thickly covered over with *petechiæ*, red and livid, which here and there ran into *vibices*, as if he had been severely scourged.

"I ORDERED him to take a drachm of the *cortex* every hour, washing it down with four ounces of the *infusum amarum* of the London dispensatory, with thirty drops of the *acid elixir* of *vitriol* in each dose.

" AFTER

"AFTER taking a few doses, he imagined himself better; and therefore, of his own accord, took it every half hour. The 7th, the blood disappeared from his urine, and greatly abated from his mouth and nose; the livid *petechiæ* changed to red, and the *vibices* into distinct *petechiæ*. The 11th, all the hæmorrhages ceased, and the *petechiæ* had almost disappeared. On the 15th they were entirely gone. He continued his medicine, however, until the 27th; on which day, his *herpes* was completely skinned over. During this time, viz. from the 3d to the 27th, he took fifteen ounces and six drachms of the *cortex*."

THE antiseptic virtue of the other gummy resinous vegetables, if we may judge of them all by this capital one, the *cortex*, appears also to depend on their fermenting in the body; and as these substances contain a large proportion of the *fixed air*, they must part with much of it in the course of their fermentation: For now that we have taken a view of the several kinds of *antiseptics*, and have seen how much the action of *salts*, and of *astringents*, is limited, we find that the only dependence

ence must be on those things which throw a great quantity of air into the blood, if we expect to work a complete change on the whole mass.

If we attend also to the things that prevent putrefaction in living bodies, we shall still find that the dependence is on the quantity of air.

THERE can be no doubt but that it is the vegetable part of our food which yields by far the greatest share of the air, that enters the composition of the animal fluids; and vegetable food most certainly prevents the *putrefactive diathesis*. Sir John Pringle ascribes it, and with great justice, to the frequent use of fresh vegetables and sugar, which now make up so great a part of the diet of the *European nations*; that we at this day so seldom hear of the dreadful putrid diseases which formerly swept off such multitudes, every thirty or forty years, and generally went under the name of plagues*.

THE effects of being deprived the use of fresh vegetables, are strongly manifested in

* See also *Hoffman*, in the chapter *de Venenis in Aere Contentis*, &c. sect. 26.

the fatal scurvy, fevers, and dysenteries, to which seamen, and people pent up in garrisons, are often subject: In short, this matter is so well known, and every body is so sensible of it, that it would be a trespass on the reader to insist on every particular instance; I shall therefore only request, that he may observe, in general, the kind of diet which is most wholesome in hot climates; that it must, in order to preserve health, consist very much of vegetables, and of those kinds which produce the greatest quantities of air, in order to afford a sufficient supply of *antiseptic vapour*, to make up for the extraordinary waste of air which is carried off from the fluids by profuse perspiration; and that those people must inevitably fall into putrid diseases, who eat much animal food, which produceth but little air; who drink much spirituous liquors, that contain no air themselves scarcely, and prevent the ready extrication thereof from the aliment, during the digestive process; and who incautiously expose themselves to a moist atmosphere, which hinders any thing but the *aerial* part of the perspirable matter to be carried off.

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THIS general and well known *antiseptic* quality in *vegetable food*, is commonly accounted for by saying, that it produceth *acescent chyle*; but *alcalescent* or *putrescent* vegetables are equally powerful, in this respect, with the *acescent*; therefore, the *antiseptic* quality must depend upon something that is general, and common to all vegetables*.

INSTEAD of calling *chyle* produced from a vegetable diet *acescent*, we shall speak with more propriety, as well as approach much nearer to the truth, by terming it a fluid composed of animal and vegetable juices, in the *first* or *sweet* stage of *fermentation*, impregnated and fully charged with a subtle, active, and penetrating spirit, which is highly *antiseptic*.

THIS

* By far the greatest share of the vegetables used in common diet, if we except the *fruits* and *farinacea*, are *alcalescent* or *putrescent*; witness all the different kinds of *brassica*, the *nasturtia*, *onions*, *leeks*, *garlick*, *horse-radish*, *mustard*, *radishes*, *spinage*, *endive*, *purslain*, *lettuces*; not one of these things can be called *acescent*, and yet they preserve the humours from putrefaction, or correct it when present, as effectually as *sorrel* or *lemon-juice*. We sometimes find it in systematic writers, laid down among the general causes of the *putrefactive diathesis*, the

THIS notion of *acescent chyle* has such an influence on the practice of physic, that it is apt to present *acids alone* to the consideration of the physician, in *putrid cases*, and too often diverts him from ordering those things which are the true opposers and genuine correctors of putrefaction, namely, fresh vegetables, and other fermentable matters; since *these*, upon comparing all the circumstances, will be found the *grand antiseptics*, that not only have the power to *preserve* animal fluids from corruption, but can also *restore* them, after having undergone some degree of putrefaction.

BUT what proves almost to a demonstration, the antiseptic power of the fermentable substances, is the cure of the *sea-scurvy*. This disease, wherein the whole mass of fluids is dissolved and corrupted, cannot be cured by any other means than by throw-

the too liberal use of such sort of vegetables; but I apprehend there are few, if any, instances of a putrid disease arising from the use of any sound, fermentable vegetable.

Indeed, where people have been obliged to feed on such vegetables as were unsound, and incapable of the alimentary fermentation, there it will readily be granted, that the very worst of putrid diseases have ensued.

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ing in a large quantity of *new air* * ; and this must be done in the way of diet ; it must be furnished from things that can be taken into the body by pounds, not in ounces or drachms ; and therefore that vegetable is found to be the most powerful antiscorbutic of which the patient can take the largest quantity, without occasioning sickness, or other disturbance.

In the *scurvy*, the *digestive organs* luckily preserve their full powers, and therefore they can turn the fermentable substances, taken into the body, to their own proper advantage ; and hence this disease scarce ever fails of being cured, provided the requisite materials be supplied.

BUT in *acute* diseases, arising from putrefaction, the case is far otherwise ; every

* With regard to practice, it is of no consequence whether the antiseptic power be ascribed to air, or to the *volatile vegetable acid* ; since it appears, that these *two* are so *inseparably* united, that when the *one* is disengaged from any particular substance, the *other* must necessarily go along with it. The thing that is of real importance, is to point out those medicines, and that kind of diet, which are capable of furnishing the *antiseptic spirit* in the greatest abundance ; and this, it is presumed, has been sufficiently done by the preceding Experiments.

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thing,

thing, here, is thrown into such confusion, that none of the animal processes can be carried on with regularity; and, on this account, the most powerful antiseptics, as well as every thing else, too often lose their power.

As the cure of the scurvy, then, seems to depend so very much on the *fermentative quality* in the remedies made use of, it is not impossible but other things, as well as *perfectly fresh vegetables*, may be found to answer this salutary purpose.

I IMAGINE that I have found out such a substance; I have had no opportunity, indeed, of putting it to the trial; but as I am firmly persuaded that it will be found of great service, not only in the *scurvy*, but in other *putrid diseases*, at sea, where fresh vegetables are not to be had, I cannot refrain from throwing out a proposal for trying *new methods* of preventing, and possibly curing, those destructive diseases that take their rise from putrefaction, in situations where the unhappy patients are destitute of the most proper means of help; but as this requires a particular consideration, it shall be made the subject of another *Essay*.

HOWEVER, I will, in the mean time, recommend the trial of an experiment in that very destructive disease, the *putrid yellow fever* of the *West-Indies*. And if these papers shall happen to fall into the hands of any practitioner in those climates, I request that it may be tried.

It is, to give the patients repeated doses of the *alkaline salts*, in fresh *lime juice*, or the like, and let it always be swallowed during the effervescence; and let the patient's drink be somewhat of the highly fermentable kind; I would even propose the juice of the *green sugar-cane*, diluted, and acidulated with some of the recent four juices*.

POSSIBLY, by throwing in such a quantity of antiseptic vapour as would be furnished from this kind of materials, the putrefactive acrimony, which at first seems chiefly to affect the biliary system, might be corrected and saturated.

* Mr. *Mornington*, surgeon to the 69th regiment, who was some time at *Goree*, on the coast of *Africa*, tells me, that the natives give in these fevers, with very good success, a drink prepared by macerating in water a fruit of the plum kind, that grows there in great plenty.

THE principle on which the saline mixtures, when given during the ebullition, perform their action of sweetening and destroying the putrefactive acrimony, the reader can be no stranger to; or if he does not recollect it, he has only to turn back to the 23d, 24th, and 25th experiments of this present essay †.

† Or, if the reader chuses to have their action accounted for in another manner, I refer him to Dr. Barry's Treatise on the three digestions, page 50, or to Dr. Whytt's book on nervous disorders, page 485.

ESSAY

E S S A Y IV.

ON THE

S C U R V Y;

WITH A

PROPOSAL for trying NEW METHODS

T O

Prevent or Cure the same at Sea.

ESSAYS IV.

ON THE

SCURVY;

WITH A

Proposal for trying New Methods

TO

Prevent or Cure the same at Sea.

ESSAY IV.

SCURVY; with a PROPOSAL for trying NEW METHODS to pre- vent or cure the same at Sea.

FOR some time, even before I engaged
in the course of experiments which
have been set forth in the three preceding
essays, I was firmly of opinion, that the
cure of the *sea scurvy* depended chiefly, if
not altogether, on the *fermentative quality* *

* Although the ingenious Dr. Lind ascribes somewhat
to the fermentative quality, yet his theory rests chiefly
on the *saponaceous, attenuating, and resolving* virtue,
which, according to him, "is the chief, and most ef-
" fectually requisite quality, in the antiscorbutic mix-
" ture." P. 304 of his *Treatise*.

The theory, which makes the cure to depend on a
change produced in the diseased fluids, in consequence
of the fermentation of the fresh vegetables in the sto-

of the *fresh vegetables*; which are found, by experience, to be the only things that, with certainty, conquer this destructive disease. And in consequence of this persuasion, it occurred to me, that as there are vegetable substances, which, though not perfectly recent, are yet capable of fermentation, such in particular as *common malt*; that this, if taken in the way of medicine, would, in all probability, produce effects similar to those produced by green vegetables, and consequently cure the scurvy; and as *malt* can be preserved sound, for a considerable length of time, it might be carried to sea, and there kept, in order to make *wort* occasionally as it might be wanted; and thus prove a remedy, always in readiness, against that fatal disease.

SUCH was the scheme that I framed to myself; and the more I thought of it, the more I became convinced of the likelihood of its succeeding.

I soon mentioned this affair to a set of medical friends, who having formed themselves, as I am informed, by Dr. Cullen, but was suggested to me by Dr. Hutcheson,

themselves

selves into a little society, meet once a fortnight for their mutual improvement; and they thought the reasons on which my expectations were founded so plausible as to deserve the trouble of an experiment: So that all that was now wanting was an opportunity of putting it to the fair trial.

BUT as the *scurvy** is a disease very rarely to be met in this city†, and as I had not any acquaintance at the places where cases of this sort occur most frequently, I drew up my reasons for thinking that the wort would prove a remedy, in the form of a letter, and addressed it to my very worthy friend Mr. George Gleg-born, lecturer of anatomy in the university of *Dublin*, with a desire that he would send it to some of the leading medical people in *London*, in order to engage them in an application to the gentlemen who have the care of the naval hospitals, that trial might be made of its effects at those places.

* The genuine putrid scurvy, so fatal to seamen, and to people shut up in garrisons, without supplies of fresh vegetables, is the disease every where meant throughout this Essay.

† *Dublin*,

AMONG

AMONG the gentlemen to whom Mr. *Clegborn* transmittted copies of the letter, were Dr. *Hunter*, and *Henry Tom*, Esq; then one of the *comissioners* for taking care of *sick* and *wounded seamen*, whose zeal in the prosecution of this affair, and in endeavouring to get the proposal carried into execution, demands a public acknowledgment; since it was through their application, that the *lords* of the *admiralty* did, in the month of May, 1762, give orders to have the *wort* tried in the naval hospitals at Portsmouth and Plymouth.

BUT as it was absolutely necessary, in order to determine the genuine effects of the remedy proposed, that the patients should, during the time of trial, be entirely debarred from every sort of recent vegetable, this restriction was deemed so severe, and looked so like retarding men's cures, for the sake of experiment, that it occasioned a general murmur and disgust, and, of course, put a stop to the further exhibition of the *wort* at the hospitals*.

Orders

* I had the honour of a letter from Dr. *Huxham*, dated October the 13th, 1764; wherein he tells me, that the *wort* was tried both at *Plymouth* and *Portsmouth*,
with

Orders were then issued to have it given on ship-board, while at sea, where no temptations of fresh vegetables would offer to make the men uneasy, and where it was expected that the patients would cheerfully submit.

But hitherto, † no return has ever been made to the offices, either of the good or bad

with very bad effects. He has not indeed specified what these bad effects were; but it is easy to conceive, that the patients, when laid under the restraints above-mentioned, would make a variety of grievous complaints. However, I am perfectly well-assured by a gentleman, who himself made use of the Wort, that it may be taken for a length of time, to the quantity of a quart in the day, without producing any ill effect whatever: and by looking into *Van Swieten's* commentary, the 4th vol. p. 673: the reader will see that the *Burton's* lady, when a nurse, used regularly to drink a pint of it every night going to bed, in order to increase her milk.—See the appendix, No. 3 and 4.

† In a letter, dated 17th Feb. 1763, which I was favoured with from Mr. Tom, I was told, that at that time none of the navy-surgeons had reported any thing concerning the Wort; but he engaged to acquaint me of the particulars, so soon as a return should be made to the office.

But as I have never had the pleasure of hearing from him since (it is now 12th Dec. 1766) I take it for granted that nothing has been done in consequence of that order,

bad effects of the *wort*; yet, nevertheless, as I am now, in consequence of those experiments which have been already made known to the reader, more than ever convinced that the cure of *putrid* diseases in general, and that of the *scurvy* in particular, depends greatly on the quantity of *new air* thrown into the blood from easily fermentable substances, I should deem myself wanting in common humanity, if I did not communicate this to the public, and make it my request, that such people as are concerned in long voyages may embrace some opportunity of giving the *wort* a fair trial; for until it is disproved by actual experiment, I shall still continue to think, that this liquor bids as fair to cure the *scurvy* as the juice of any recent vegetable. The experiment can occasion no possible

der, nor any report ever made. There has, however, been a new order issued this last summer. The ships which sailed (as is supposed) in order to make discoveries to the Southward, were directed to carry out a quantity of malt, and to make trial of the *Wort*, if occasion shall offer: and this was done in consequence of an application (as I have been informed) from a gentleman who is equally remarkable for humanity and generosity, as for extensive practice and knowledge in his profession—Mr. Adair the surgeon.

danger,

danger, will be attended with very little expence or pains, and, if it succeeds, will make ample amends, in producing a discovery of infinite advantage to the seafaring part of mankind.

If it be true what was published in December, 1762, taken, as is supposed, from returns made to the House of Commons, that of *one hundred and eighty-five thousand* men, raised for the sea-service, during the late war, above an *hundred and thirty thousand* perished by diseases, and that two-thirds of this number may be safely charged to the account of diseases which take their rise from putrefaction; surely, every motive of policy and humanity should excite men to endeavour at finding out somewhat to check this fatal and destructive *diathesis*; for if seamen could be preserved from it, few other kinds of diseases would endanger them.

For a sea-life, simply considered, is so far from being productive of diseases, that it is found to be a remedy against some of the most dangerous kinds; * and though

* See Gilchrist's ingenious discourse on the *Use of Sea Voyages in Medicine*.

habitual intemperance, and incautiously exposing themselves to heat and cold, may, and frequently do, cut short the lives of seamen, yet the great mortality to which the crews of the king's ships are too often subject, ariseth from infectious diseases, owing to such numbers being crouded together, and living in circumstances less cleanly than is usual in the merchants service, where the men breathe a purer air, and are in general cleaner, and better cloathed, though by no means better, nor perhaps so well, fed as in the royal navy.

WHOEVER has read Dr. Lind's excellent treatise on the *scurvy*, must be convinced that the principal and main predisposing cause is too great a degree of moisture in the atmosphere, whether hot or cold, but more especially the latter; and that the use of salt diet, bad water, or foul air, can only be reckoned as secondary causes, which will not of themselves produce the disease.

THE manner in which excessive moisture brings on the putrefactive diathesis, we have already attempted to explain; and have endeavoured to point out the most effectual methods of preserving the body from its ill effects.

It has been alledged, that this depends very much on keeping the surface of the body always warm and dry, by wearing enough of clean apparel to absorb the *aqueous* part of the perspirable matter; and, at the same time, making use of such diet as will supply a sufficient quantity of that principle, which is known, from experience, to correct the morbid disposition, or tendency to putrefaction.

BUT here a question naturally presents itself; Where are the bulk of the crew, the poor common sailors and marines, to get such kind of diet; or how are they to be always kept clean, dry, and warm, who, for the most part, have not a second suit, but are obliged frequently to lie down in wet cloaths, and go to sleep in damp hammocks?

To this it may be answered, Let the men in the *navy* be cloathed in the same regular, exact, and uniform manner as they are in the *army*; and let them be allowed, *while at sea*, a daily portion of *sugar*; and I will venture to promise, that, in a time of war, we shall annually save some thousands of very useful lives.

WHEN

WHEN thinking on this subject, I have often lamented, that it has never been attempted to clothe the seamen in this manner. Such a scheme, as it would occasion considerable changes in the present naval system, could not be carried into execution without some difficulty; but if it were once established, it would certainly be productive of great and solid advantages, for it would attach the men firmly to the service, and prevent a great deal of desertion, by infusing more powerfully that *esprit du corps*, which binds people so strongly together; and it would, without all manner of doubt, render the fleet much more healthy; for the greatest share of those terrible *putrid* diseases, that sweep off such multitudes of our seamen, take their first rise from a want of necessary cloathing; a species of distress which numbers of people, as things are now ordered on board the king's ships, must often labour under.

THE great importance of necessary cloathing may be plainly seen, by observing what happens to the commission, warrant, and petty officers, on board the fleet; together with such of the common seamen as are careful and provident, and pride themselves

themselves upon being always neat and well cloathed. These people are scarce ever seized with *acute* putrid diseases, excepting by mere infection; and they are very seldom known to become *scorbutick*, to any violent degree, unless the *general cause* (excessive moisture) be of a remarkable long continuance.

Now, the diet of all this set of men (the commission, and some of the warrant and petty officers excepted) * is precisely the same with the rest of the crew, being nothing better than the common ship's provisions; and many of the petty officers sleep in a part of the ship, where the air must be even more confined than it is where the common men sleep.

The only circumstances wherein the people of whom we have been speaking usually differ from the common run of the crew, are, that they are *well clad*, and, for the most part, never want a little store of *sugar*.

* If these gentlemen fare better than the rest of the crew, it must be all at their own expence; for the government provides nothing better for the officers than it does for the meanest person in the ship.

N

It

IT would lead me from my purpose to pursue this matter any further; but the importance of it is so obvious, that I most heartily wish that some person, whose rank in life would insure him the public attention, would take the hint, and offer a plan for the regular cloathing of the seamen in the royal navy; the time being now come when such a thing might easily be attempted: the naval establishment being brought so low, and the several commanders fixed to their ships, for at least some years, will give leisure and opportunity for trying if such a scheme can be carried into execution.

BUT although the cloathing scheme should never take place, yet the other part of the proposal may be easily adopted; and I sincerely wish that *sugar* or *melasses* may hereafter be allowed, as a part of *sea provisions*.

THE expence, even taken at the highest, is too trifling, when put in competition with preserving so valuable a part of the community as our seamen: but I am convinced, that the government would rather be gainers by affording the seamen this allowance; for the savings at the hospitals, which

which would not then be crowded in the manner they have often been, would more than pay for all the sugar expended *at sea*.

THE reader must have already perceived the principle upon which it is proposed to cure the *scurvy* by the use of *fresh wort*: but as I do not imagine that any person will take the trouble of making the experiment, unless he is almost as fully persuaded as myself, I am under the necessity of entering into a farther explanation of the reasons which lead me to expect that this liquor will produce such salutary effects.

NOTWITHSTANDING the many impudent assertions every day published in the common news-papers, which, among other much-boasted remedies, promise not a few as peculiarly specific against the *scurvy**,

N 2

yet

* If any of these *nostrums* be *spirituous tinctures*, the material from whence they are extracted, if it ever had any antiscorbutic virtue, must be deprived of it by this manner of treatment; and the tincture itself must be so far hurtful, as every kind of ardent spirit is found to be extremely pernicious in this disease.

If they be *mineral acids*, they are sufficiently known from experience to be useless, either as remedies or *prophylactics*.

But

yet it may be laid down as a position, not easily to be contrbverted, that the *genuine putrid scurvy* has never been known to yield to any other medicines than to such as are composed of *fresh vegetables*; * and provided they be *fresh*, and of such a nature as will allow them to be taken freely, it is almost no matter what they are. The *acid* and the *alcalescent*, the *mild* and the *acrid*, the *sweet* and the *bitter*, all of them

But if they contain *mercury* they must be as so much poison; for mercury breaks down the blood, and destroys its texture, in like manner with the scorbutic acrimony.

* The only places where I meet with any thing like a contradiction to the above assertion, are in *Bisser's Account of the Scurvy*, and in the History of the Voyages made by the *Russians*, in order to discover the *American* coasts opposite to *Kamischatta*.

The first-mentioned author thinks that many people were cured at *Cumberland harbour*, in the island of *Cuba*, merely by feeding on *rice*, and before they were supplied with any recent vegetables. See p. 83 of his treatise.

And in the last-mentioned book, the cure is entirely ascribed to eating the flesh of the sea-cow. But the authors do not take notice, that the same spring-season, and warm-weather, that induced these animals to seek the land, must also have thrown up a variety of vegetable productions, which the scorbutic patients would most greedily devour, without waiting for the doctor's directions.

cure

cure the *scurvy*; though their sensible qualities be so opposite, and their manner of affecting the body, in ordinary cases, be so different.

THIS virtue, then, *must* be owing to some property which they all possess in common.

THE experiments of the three preceding essays will, as I apprehend, be allowed conclusive, in shewing that a property, common to all *fresh vegetables*, is, that when mixed with any *animal substance*, and placed in the proper degree of heat, they presently run into *fermentation*, and, in the course of that fermentation, throw off a subtile *vapour*, or spirit, of surprizing activity, endued with a power of *restoring sweetness to putrid animal fluids*.

THIS hath been so clearly and so abundantly proved already, that there cannot be the least necessity for repeating what hath been said of it in the three foregoing essays; I shall therefore only mention some circumstances with regard to the *cure* of the *scurvy*, which will afford almost a demonstration, that it depends on the change brought about in the diseased fluids, by the action of the subtile, active, and pene-

trating spirit, which is generated during the fermentation of the fresh vegetables, carried on in the first passages.

FIRST, the recovery of people in the very *last stages* of the *scurvy*, is brought about in a surprisingly short space of time, provided the patients are but fully supplied with *fresh* vegetables. This is sufficiently confirmed by every account of the scurvy that we meet with; and *John Woodall*, an old English surgeon*, who hath left us a very

* Although *Woodall* was a man of great eminence in his day, and of no inconsiderable merit as a writer, yet his book appears to be very little known. The only places where I see it mentioned, are in *Wiseman's* preface, and in the preface to *Turner's* surgery; but it is not to be found in *Haller's* catalogue, neither in *Heister's Bibliotheca Chirurgica*; nor, which is still more to be wondered at, in *Lind's Bibliotheca Scorbatica*; notwithstanding that *Woodall* hath left a very excellent discourse on the scurvy, his description of which appears to have been drawn from his own observation, and his method of cure founded on experience, for he served both at sea and in the army. For these reasons, I am persuaded that the reader will be pleased to see an extract from this part of his works, which consist of several discourses on medical, chemical, pharmaceutical, and chirurgical subjects, printed originally at different times, but all collected by himself, and re-published in a thin folio, in

very accurate description of the disease, paints this salutary change in a very striking manner, by saying, "That to any man of judgment it may seeme a wonder, how a poore miserable man, coming on lande from a long voyage, even at the point of death, namely, swolne sometimes to an exceeding greatnesse, not able to lift a legge over a strawe, nor scarce to breathe, by reason of strong obstruction, yet, in a few dayes, shall receive the fulness of former healthe, yea, with little or no medicine at all."

SURELY this change must be wrought by somewhat of amazing activity, and does not depend on a *saponaceous, attenuating, or resolving* virtue; for in the *scurvy* the "crasis of the blood is broken and destroyed by the scorbutic putrefaction;" and certainly never can be restored to a sound state, by being further attenuated and resolved; neither have we sufficient time, in these cases, "for the putrefactive acrimony to be diluted, and obtunded by the watery and mucilagi-

in the year 1639, with a dedication to King Charles, under the title of *The Chirurgion's Mate, or military and domestic Surgery*.

“ *nous parts, and carried out of the body by*
 “ *the aperient quality of the vegetable juices.*”
 Nor does the mechanical action of “ *scour-*
 “ *ing and cleansing the furred and obstructed*
 “ *passages of the machine,*” * at all corre-
 spond or agree with the appearances that at-
 tend the progress of the cure; which is al-
 ways found to depend on vegetables only so
 far as they are *fresh* and capable of yielding
 a large proportion of the *antiseptic spirit*;
 for although the dry *farinacea*, when mix-
 ed with the animal juices, ferment very rea-
 dily, yet both reason and experiment shew,
 that they will not do it with so much ease,
 nor produce so much air, as the fresh succu-
 lent vegetables; therefore, notwithstanding
 that bread, without any other vegetable
 assistance, will serve, in ordinary cases, to
 raise the common and necessary alimentary
 fermentation, and produce enough of the
 antiseptic vapour to *preserve* the juices in a
 sound state; yet if a *putrid* acrimony hath
 once taken place in the constitution, the
crude and *dry farinacea* are found quite in-
 sufficient to conquer it; and there is then
 an absolute necessity for throwing in a large

* See *Lind on the Scurvy*, p. 304, 306.

quantity

quantity of *fresh vegetable juice*, not so much to obtund and sheath the putrefactive acrimony by its mucilaginous quality, as by its *fermenting* in the bowels, to generate a sufficiency of the subtle spirit, which seems to be the only thing capable of pervading, in so short a time, the most intimate recesses of the whole vascular system, and of totally changing the corrupted nature of the entire mass of fluids.

SECONDLY, the liquors which have completed their first stage of fermentation, and thereby lost much of their *fixed air*, though they are found useful as preservatives, will none of them *cure* the disease: Cyder, which appears to have a greater degree of antiseptic virtue than any of the common fermented liquors, is generally stopped sooner in its career of fermentation, and contains the more *fixed air* on that account*.

* See the note in page 145. Experience has proved that Cyder has been tried at sea, on the recommendation of Dr. Huxham, and he tells me, in the letter mentioned in a former note, that it was used in the navy with great success.

THIRDLY,

THIRDELY, *acids* *, both mineral and vegetable, and *ardent spirits* †, which contain little *fixed air* in themselves, and check the alimentary fermentation, are found to be, the first, useless and insignificant; and the second extremely hurtful, in the disease.

UPON the whole, then, it may safely be repeated, that the *cure* of the *scurvy* depends on the *fermentative quality* in the remedies made use of.

AND this being the case, we have only to find out a substance which may be preserved for some considerable length of time, and yet shall contain materials for raising a fermentation in the bowels like that raised by fresh vegetables; and then, in all human probability, we shall have a remedy for the *scurvy* always in readiness.

SUCH a vegetable substance, it is presumed, is *common malt*.

* “ Experience has abundantly shewn, that they
“ (*Sp. Salis, Elix. Vitrioli, and Vinegar*) have not been
“ sufficient to prevent this disease, much less to cure
“ it.” *Lind*, p. 187.

† This is strongly proved by the remarks of governor *Ellis*, in his account of the voyage to *Hudson's Bay*.

GRAIN, after it is *malted*, differs widely from grain in the *crude state*; by the germination, drying, and slight torrefaction, its natural viscosity is destroyed, it acquires an agreeable saccharine taste, and the farinaceous part is so attenuated as to be rendered soluble in water.

FRESH wort, or *infusion of malt*, is a liquor similar to the recent juices of the sweet vegetables; fermenting readily like them, and being precisely of the same mild, saponaceous, and aperient nature.

WHAT then should hinder it from producing the very same effects? and, as it may be taken in as large a quantity, with as much safety, and with as little disgust, there can be no reasonable objection to its being given. All that remains, then, is to put it to the fair trial; and this I certainly should have done, long ago, if an opportunity had ever presented itself.

BUT the same objections that were made at the naval hospitals, must always be made, as often as the experiment is attempted on shore; therefore, whenever it shall be fairly tried, it must be at sea.

Let me then again request, that such of
my

my readers as may have opportunities, will try the effects of this liquor*: and this is a matter of such importance, as to render it well worth the bestowing of some expence and pains; for if the *wort* should be found to answer, it will undoubtedly be the means of saving the life of many a brave fellow.

For malt, as I am assured by the brewers, with proper care, may be preserved sound and good for years; so that if it were previously well dried, packed up in small casks, and stowed in the bread-room, or some very dry part of the ship, it might be carried to sea, and kept for any length of time that would be required, even in the longest voyages; and as there need be no very large quantity carried, it would not incommode the ship by its bulk; since I do not mean, that it should be given as a part of the common diet, in the way of preservative, but only to such as are ac-

* The *East-India Company* would do well to order some malt to be carried out in their ships, and give positive directions to have trial made of its effects, as there never fails to be abundance of opportunities during the course of these voyages.

tually

trually sick; when the *mak* is to be ground, and made occasionally into *wort*, as it may happen to be wanted.

THE method in which I would propose the *wort* should be given, is, to boil it up into a *panado*, with the sea-biscuit; and some of the dried fruits that are usually carried to sea; then let the scorbutic patients make at least two meals a-day on this palatable mess, and let them drink a quart, or more, if it shall be found to agree (always beginning, however, with a smaller dose, and gradually increasing it) of the *fresh infusion*, in the course of the twenty-four hours.

Its most likely effect will be to open the belly, a most agreeable circumstance to the poor scorbutics (in whom obstinate costiveness is a very common symptom) and exactly similar to the *modus operandi* of the most powerful *green antiscorbutics*.

BUT like them too, if taken too liberally, it may occasion griping, and immoderate purging; when this happens, the dose must be lessened, and some drops of the *acid elixir of vitriol* may be given with it, in order to check the too great tendency
to

to fermentation, and make it fit easy on the stomach.

AND it is not only in the *scurvy*, but likewise in *acute* putrid diseases, that I expect the *wort* will be found of singular service. In all such where the putrefactive acrimony seems to be unaccompanied with any *peculiar pestilential taint*, it promiseth to produce very good effects, from the principles already laid down; for as most of these *simple putrid* diseases arise from an accumulation of sharp and corrupted matter, in the first passages, such medicines as will *dilute, obtund*, and above all *ferment*, and, in that action, produce a sufficiency of the *antiseptic vapour* to saturate and sweeten the putrefactive *colluvies*, bid the fairest to give present relief.

IN these cases, the *wort* may make a principal part of the sick person's diet; a thin panado for meat, and the plain infusion, acidulated with lemon or orange-juice, if to be had, if not, with spirit of vitriol, for the common drink.

AND this will bring things as near as the circumstances and situation will allow, to the very successful practice of the celebrated *De Haen*, at *Vienna*. In acute, continual, putrid

putrid fevers, his method is truly *Boerhaavian* and *simple*, consisting only in supplying the patients liberally with *oaten* or *barley* gruel, sweetened with honey, and made of different degrees of thickness, according as he intends it for meat or for drink; though, in some cases, they are indulged with flesh broth, made very light and thin. If the belly is not made soluble by the gruel alone, he occasionally mixes a little *cream* of *tartar*, or *nitre*: His medicines are all of the fresh fermentable kind; *flowers*, *leaves*, *succulent-roots*, and *ripe fruits*, made into decoctions, or infusions, according to the nature of the different materials: And his only cordials are decoctions of bread, made palatable by the addition of the more pleasant kinds of fruit, when in season, or at other times, by the same, preserved, and made into jellies, syrups, or what is usually called *jam*; with now and then some small doses of the milder *antimonials*, or some of the *neutral salts*: Nor does he ever give his patients any of those trifling and insignificant mixtures which fill up the *German* dispensatories.

By these plain, simple, and pleasant remedies, he finds the extraordinary sickness
 3 and

and nausea, which attend all these putrid fevers at the beginning, is presently allayed; insomuch, that he scarce ever thinks of giving an *emetic*. The tormenting thirst is so effectually relieved by these diluent, mild, and saponaceous drinks, that the patients very soon forget to complain of it; and by their power, likewise, the putrid acrimony which occasioned the disease, is early obtunded and corrected, the disturbed secretions are presently restored to order, and the whole mass of humours preserved from corruption and dissolution: Hence, patients with petechial and miliary eruptions, proceeding from a dissolved state of the fluids, are rarely to be seen in the hospital that *De Haen* has the care of; neither are his patients afflicted with violent vomiting or purging, the acrimonious matter being so early corrected, that even the appetite frequently returns, during the very course of the fever*.

DE HAEN, agreeably to the common theory, makes the virtue of all these things to depend on their producing *acescent chyle*; but how liable this way of ac-

* *De Haen, Ratio Medendi, in capite 1^o & 2^o.*

counting for it is to objections, the reader hath already been informed: It is on account of their *fermentative quality*, and on their producing much of the *antiseptic vapour*, that all these things perform such wonders; and if they actually do perform them, there is all the reason imaginable to expect that the *wort* will not come far short: I do therefore again most earnestly recommend a trial of it, in the *acute*, as well as in the *chronic* putrid diseases*.

ALTHOUGH I have all along insisted on the *wort*, as thinking it comes the nearest to the *fresh* juices, in every respect, yet,

* In *Tissot's Avis au Peuple*, the reader will meet with many instances of the good effects of fresh vegetables in putrid diseases, particularly the dysentery; a disease, which vulgar prejudice has often ascribed to the eating of fruit:—One instance is so very striking that I cannot forbear transcribing it.—In the year 1751, the putrid dysentery made great havoc in Switzerland, and in the south of France. “The distemper having
“nearly destroyed a Swiss regiment, the captains purchased the whole crop of several acres of vineyard;
“there they carried the sick soldiers, and gathered the
“grapes for such as could not bear being carried into
“the vineyard; those who were well eating nothing
“else. After this not one more died; nor were any
“more ever attacked with the dysentery.” See p. 342 of the translation, by Dr. Kirkpatrick.

O

where

where *malt* is not at hand, I would recommend that *melasses*, *honey*, or *sugar**, may be tried, dissolved in a due proportion of water (about four to one) and given in such manner as may be found most agreeable and convenient to the patients.

THE method in which it is proposed to prepare the *wort*, is, to take *one* measure (suppose a quart) of the *ground malt*, and pour on it *three* measures of boiling water; stir them well, and let the mixture stand,

* Dr. Cullen, who has very sanguine expectations from the *wort*, thinks that *sugar* bids fair to cure the *scurvy*, as well as the *wort*: And it certainly does so; for the same reasons that lead us to expect that the one will prove a remedy, hold good, in almost every circumstance, with regard to the other.

New spruce-beer is known to be a most powerful antiscorbutic; but this virtue seems to depend chiefly on the *melasses* that is mixed therewith, in order to make it ferment; for I apprehend that a decoction of *dried fir-tops*, alone, would no more cure the *scurvy*, than the decoction of any other dried vegetable, great variety of which have been tried, but always without success. See the appendix, No. 5;

Honey, on the same principle, must be a good antiscorbutic, and, as such, may be recommended to officers, and others who can carry it conveniently, to eat some daily, which would, in all probability, keep off the extreme costiveness to which people at sea are so very liable.

close

close covered up, for three or four hours ; after which, strain off the liquor.

IT must be brewed, in hot weather especially, fresh every day ; for if it be allowed to grow vapid, or sourish, it will not only be unpleasant, but useless, as it would not then run easily into fermentation ; but when perfectly fresh, there cannot well be a more palatable kind of drink ; and I dare say, that, in general, it will sit light and easy on the stomach.

IF what hath been urged shall be found of sufficient weight to engage any gentleman in a trial of the *wort*, all that I have further to request, is, that he will, previous to its administration, carefully and particularly note down the cases in which it is given ; describing with accuracy the several symptoms, and relating fairly, and with candour, the progress and effects, from time to time ; and let these observations be communicated, either to the public at once, or to the author at *Dublin*.

1

A P P E N D I X.

N^o I.

An EXTRACT from that Part of
WOODALL'S WORK which treats
of the SCURVY.

HE prefaceth his discourse on the scurvy with lamenting, "That none of his countrymen had, out of their experience, taken in hand sincerely to set down to posteritie the true causes, signes, and cure thereof; neither left any caveats, instructions, or experiences, for the prevention or cure of the same." He therefore declares his intention "of informing the chirurgeon how he should demean himself, to comfort his patient at sea, in that most dangerous disease;" which, he tells his reader, "is a disease of the spleene, whereby it is sometimes wholly stopped, and sometimes only distempered."

HAVING bestowed a paragraph or two on the different names of the disease, he goes on to treat of the causes, signs, and method of cure, expressing himself in the following terms.

“ THE causes are so infinite and unsearchable, as they far exceede my capacity to find them out: Some men conceive this disease happeneth unto seamen only through their being long at sea without touching at land, as at their coming on land, they presently grow strong again, and are, by the very fresh aire, and fresh food, cured, without much other helpe. The chief cause thereof is the continuance of salt diet, which is not to be avoyded at sea, want of sufficient nourishment, and of sweete water; and also for want of *aqua vitæ*, wine, beer, or other good water, to comfort and warme their stomachs withall.

“ ANOTHER cause of this disease, to the ordinarie sorte of poore men, is want of fresh *apparel* to shift them with; which, indeed, among poor sailors, especially a sorte of them that are careless and lazie of disposition, is too frequent; partly also

by not keeping their apparel *sweet* and *dry*, and the not cleansing and keeping their cabins *sweet*; this also ingendreth and increaseth the infection. Some charge bisket as a cause of the scurvy, but I am not of their opinion; some say, inordinate watchings are the cause thereof; some say, extreme labour, wanting due nourishment; some also affirm cares and grief to be the cause thereof; others affirm, the very heat of the aire, resolving the spirits. But what shall I amplify farther? for it is also true, that they which have all the helps that can be had for money, and take as much care as men can devise, are, even by the *evil disposition* of the *aire*, and the course of nature, strooke with a *scurvie*, yea, and die thereof, at sea and land both. *

“ THE

* In the beginning of the year 1760, “ an unusual,
“ epidemic, and real scurvy prevailed over the county
“ of Southampton. Its influence extended itself sur-
“ prisingly to the ships at Spithead, and to such as were
“ hovering on the coast. It attacked some hundreds of
“ the French prisoners both in Winchester and Porche-
“ ster castles; nor were families living at their ease

“ THE signes of the scurvie are many ; as, namely, a general laziness and evil disposition of all the faculties and parts of the bodie, saving the stomach and appetite, which oftentimes is greater than ordinarie, with them, for a long time.

“ A DISCOLOURING of the skin, as if it were fouler than ordinarie, with spots darker coloured than the rest, and sometimes also darkish blue spots.

“ A FEVER at sea commonly ends in the scurvy ; wherefore, beware of too large bleeding, which oft increaseth the griefe and maketh it incurable.

“ ALSO itching, and aching of the limbs, are signes of the disease.

“ SOMETIMES, also, the legges falling away and drying, and the calves of the legges growing hard and dry ; as also immoderate swellings of the legges.

“ ALSO the legges and thighs discoloured into frekels or spots, of a dirty, brown, sad colour, much like the colour of a gangrenated or mortified member.

“ in the country exempted from a slight attack ; nay
 “ some few persons were afflicted with it in a high
 “ degree.” See *Lind's* papers on fevers and infection,
 p. 28.

“ STINKING

“ STINKING of the breath, greate obstructions of the liver or spleene, or both; and, in the exercise of their bodies, their limbs and their spirit failing them.

“ SHORTNESSE and difficultie of breathing, especially when they move themselves, but lying still, find little grieve or pain.

“ THEIR eyes of a leady colour, or like dark violets.

“ GREAT swelling of the face, legges, and all over the body; paleness, or a foul pale colour in the face; swellings in the gums, rottenesse of the same, with the issuing of much filthy blood, and other stinking corruption thence; loosenesse of the teeth: Also some are troubled with extreme costiveness, that, for fourteen days together, they go not to stoole once; also many have stoppings of the urine, or, at the least, making less water in two days than the partie drinketh in one.

“ A COLDNESSE and stiffness of the finewey parts chiefly of the legges; some also have their muscles, yea, and the sinews of their thighs, arms, and legges, so wasted away, that there seemeth to be left only the skin covering the bones.

“ ALSO

“ ALSO it is manifest, that diverse of those which have been opened after death, have had their livers utterly rotted, others have had their livers swolne to an exceeding greatnesse; some, the spleene extreamly swolne; others have been full of water; others have had the lungs putrefied, and stunk whilst they have lived.

“ THESE and diverse other signes, too many for to be mentioned here, do afflict poor seamen, which are often past man's helpe, in such time and place as they happen; the cure whereof only resteth in the hands of the Almightye.”

AFTER mentioning *Ethius* and *Vierius* as writers on the disease, and taking notice of the indications of cure as laid down by them, he says, “ he may spare his labour, in writing what broths or herbes can serve best, where no freshe food can be gotten.” He therefore goes on to direct the use of such things, as are usually carried to sea; namely, “ wine, sugar, spices, and other comfortable things, which the chirurgeon ought to take care that the men have in due season; and, moreover, he ought, morning and evening, to seeke for poore and weake men in their cabins, or, so
soone

soone as they are missing at their messes, to enquire for them, and see that their cabins be sweet, and their provisions according.

“AND whereas the first part of this cure is in opening obstructions, it is therefore fit, in the beginning of the griefe, to give an opening clyster; then the next day, if the party be strong, open a veine; but beware, as is said, of taking away too much blood at once.”

IF the disease be attended with swelling and fullness, he advises a purge, and then orders to make the patient some comfortable spoon-meat, namely, “an oatmeal caudle, with a little beere or wine, the yoke of an egge, and some *sugar*; or a broth, made with currants or other fruites, with spices and *sugar*; and, for drink, barley-water, with some juice of lemons, if it may be had, if not, with oyle of vitriol and *sugar*.”

“THE juice of lemons is a precious medicine, and well tried, being sound and good; let it have the chief place, for it will well deserve it. It is to be taken twice a-day, a spoonful or two with *sugar*.” In want of it, or the juice of *limes*, oranges, or citron, or the pulp of tamarinds, give
“oyle

“ oyle of vitriol, as many drops as will make a cup of beer or water fower a little, as it were, and add *sugar*, or some syrup : A decoction of bisket, and therein almonds ground, with sugar, and a little cinnamon or rose-water, is a very comfortable drink to be taken now and then to refresh the stomach.”

He proceeds then to give directions how to sweat the patients, and how to relieve extreme costiveness ; next, he directs lotions for the rotten gums, and orders the swelled limbs to be fermented with a weak lixivium, boiled up with some of the discutient and warmer kinds of herbs, and afterwards to be rubbed with particular ointments that he mentions.

In the cure of scorbutic ulcers, he remarks, that “ until the obstructions in the liver and spleene be removed, these ulcers give no place to good healing ;” and therefore advises “ all sharp and violent medicines to be shunned, and nothing but soft and anodyne things to be applied ; for otherwise, you will not only strive against the streame, but put your patient to needless disquiet, and thereby increase his disease.

“ A

“ A POTLTICE of bisket, boiled up in beere or wine, applied warm, will wonderfully comfort a weak limb, and assuage pain : But fattie things must be forborne in some cases ; namely, when the pain is sharp and quick, lest you cause putrefaction and suppuration of the humours against your will ; yea, and rather use acetous medicines and anodynes.”

THIS extract shews that *Woodall* was a man of some observation.

THERE are many good things for the time he wrote in other parts of his book ; his method of treating wounds, both common and gun-shot, was judicious and simple ; his dressings being, for the most part, very plain, chiefly dry lint, and he condemns the use of tents and escharotic applications.

WITH regard to fractures, he was an enemy to long rollers, or tight bandages.

WHEN he amputated, he often made use of the cross stitch, to keep down the flesh over the end of the stump ; and he knew how to restrain the bleeding ; by tying the vessels.

HE was the inventor of the *trefine*, which he so named from its three extremities (*a*

tribus sinibus) each serving a different purpose; and he was the first man who introduced the *enemata fumosa**; proposing also to throw up, in this manner, powders, and the like, into the intestines, in order to cure obstinate fluxes, and other diseases of those parts.

Nº II.

NOTWITHSTANDING the hasty condemnation of the *wort* at the naval hospitals, I cannot help still entertaining a favourable opinion of it, as a remedy against the scurvy and other putrid diseases; and in order to shew that my expectations are not ill founded, I take the liberty to publish an extract of a letter which Sir *John Pringle* was pleased to favour me with, soon after the publication of the first edition; it is dated 14th May, 1764.

* It may not be amiss in this place to inform the reader, that I have found, upon trial, that *tobacco-smoke*, thrown up in the way of clyster, effectually and immediately destroys the *ascarides*. And this I was induced to try upon the recommendation of Mr. *Turner*, surgeon at *Liverpoole*. See his letter to Dr. *Fothergill*, in the second volume of the *London Medical Observations*.

“ SOME

“ SOME time ago a paper of your's was put into my hands, relating to the use that might be made of malt in the cure of the sea scurvy ; I was confirmed in the same notion, by finding that unfermentable acids were not the thing, and that a ship's crew never suffered by that distemper in any great degree, so long as they were plentifully supplied with wine, small beer, or other liquors, which had not undergone a complete fermentation. During the late war, Captain *Campbell* (who had made the long voyage with lord *Anson*) then commanding the *Essex*, told me, that once upon a long cruize several of his men had fallen ill of the scurvy, and that he had cured them all on board, by taking the disease early, and feeding the sick chiefly on a Scotch dish, called Sooins, to which he added some wine and sugar. Captain *Campbell* was led to this purely from the notion of sooins being a cooling and light sort of food ; but at that time I attributed the virtue to a mild acidity, produced by a begun fermentation. According to your principle, the salutary effect of this mess must be ascribed to the facitious air, put into

into a way of being easily disengaged from the oatmeal of which the sooins are made.

“ A LARGE quantity of water is added to the meal, and put into a wooden vessel in a warm place; the fermentation is allowed to go on for about forty-eight hours, then the water is poured off, and evaporated on the fire to the consistence of flummery, from which the sooins only differ in becoming acidulous by the fermentation. Captain *Campbell* observed, that the fermentation never succeeded so well as when it was performed in a wooden vessel, which was agreeable to my experiments, and, I do not doubt, but it proceeded the better from the water's being somewhat putrid.

“ WHAT comes still nearer to your purpose, is an observation that I had this last winter from Dr. *Mounsey*, on his return from *Russia*. He said, that all the common people there, and especially the sailors and soldiers, use a liquor which they call *quass*, and which they reckon very salutary, and, in particular, good against the putrid scurvy, to which they are greatly subject.

“ THE *quass* is a dough compounded of *malt* and *rye-meal*, which they bake in ovens, and then infuse in water, till a fermentation

fermentation begins, and continues about twenty-four hours. This liquor, he says, is then drunk, is acidulous, and not unpleasant. Dr. *Mounsey* told me further, that upon reading my book on the diseases of the army, being then at *Moscow*, he had inquired at all the jails in that city, as he afterwards did at *Petersburgh*, but could not find that the distemper, which I call the jail or hospital fever, was ever known in these prisons, although they were generally pretty full, and not more cleanly than in other places: This immunity from that fatal disease, the doctor attributes in part to the greater use of vegetables, to the eating of *rye-bread*, and to the *quafs*, which those unhappy people have supplied to them in great abundance."

N^o III.

THAT wort may be taken with the greatest safety, and that it is not apt to produce any *bad effect* whatever, will appear sufficiently from the following letter; which, at the same time, shews how much may be done with respect to warding off the scurvy, by the dint of mere resolution.

P

I RE-

I RECEIVED it from captain *Bray*, a commander in the royal navy; he had been desired to make use of the wort by a brother officer, who also wrote to me for further directions for his friend, but with such an imperfect account of the case, that I imagined there might be a complication of gout or dropsy, and therefore desired to have a particular history of it from the captain himself.

“SIR, DEAL, June 18, 1764.

“I RECEIVED your obliging letter of the 9th instant; am persuaded that my complaint is an inveterate scurvy, which, I apprehend, you will readily agree to, when you have read the following account that I shall give you:

“SINCE my first going to sea, is now thirty-three years, and the first attack that I had of this disorder was in the year 1741, after being reduced very weak and low, by a fit of illness off *Cadiz*. Before I could recover my strength, I was attacked in such a manner as almost to confine me to my bed, my legs swelling to that degree, that I was obliged to borrow stockings, my own being too small. Notwithstanding the

condition

condition that I was in, kept constantly walking the greatest part of the day. I was at that time acting lieutenant of the *Salisbury*; and the fleet, under admiral *Haddock*, coming down from *Mabon*, Dr. *Lidderdale*, who was physician to the fleet, being an acquaintance of mine, I sent for him; he advised me to go to *Gibraltar* by the first ship, telling me, that it was impossible for me to recover at sea; but, like all young people, I would not listen to it, and was determined not to go in; being just superseded by the admiral, and had his promise of being made into the third vacancy that should happen, which promise made me determine, if I was alive, not to be out of the way. My good friend visited me often, and, by his good prescriptions, and the indefatigable pains I took in walking, in about two months, although at sea, I was so well recovered as to go on board the admiral's ship, and continued three months at sea in her before we returned to *Gibraltar*. Dr. *Lidderdale* has often said, that I was the only instance that he ever saw recover at sea, from so bad a condition.

“ THE next attack was in the river *St. Lawrence*, after the reduction of *Louisbourg*. We wintered at *Halifax*, where we were bound fast in ice till *April*; and having very few vegetables off *Louisbourg*, and but seldom on shore, till we were in the possession, I began to find my legs heat and itch, had recourse to a flesh-brush, and constantly had them rubbed three or four times a-day, by which I thought to have received benefit; but though I kept constantly to it, while we were in the river *St. Lawrence*, I found it gain on me, as we here had no vegetables, and this the second year that we had in a manner been without, I did not so much wonder at it. At my return from *Quebec*, had leave to be absent from the ship while she was refitting, which was about six weeks; then returned to the ship, and sailed from *Spithead* in *February*, and continued at sea in the Bay until the beginning of *August*, when I was ordered into *Plymouth*; at which time my legs begun to swell, and I was so bad that, if we had continued but one fortnight longer at sea, I should not have been able to have got from my cabbin to the quarter-deck without help; and when I got on shore, could
not

not walk a quarter of a mile, without resting three or four times. When I was in the river *St. Lawrence*, I had frequent attacks, with violent pains in my stomach, which used to last about twelve hours, and then go off; was obliged, when taken with it, immediately to go to bed, so soon as I had worked off an emetic.

“ I HAVE never had the least symptom of the gout or dropsy, have ever had a good share of health, am very fond of all kinds of vegetables, and make great use of them. I have made use of the wort about sixteen days, and find that the itching is greatly abated; but the directions that captain *Macbride* told me, is not exactly as you mention, only making use of half a pint of malt to a quart of water. It no ways disagrees with me, nor can I say that it purges me, yet I find myself somewhat easier than before I took it. I drink the quart in the twenty-four hours, and the greatest part of it fasting. I was broke out before I begun the wort, but much more since; it is out somewhat like a surfeit, itches, are very fore, stand up above the skin, and die away with a scurf, leaving a mark behind as after the small-pox, first red, and then turn

brown, and never after alter the colour. I am going over to *France*, for about three weeks, to see my son; and, as soon as I return, shall begin and follow the directions you have been so kind as to send me, for which I return you many thanks; and if, at any time, it should be in my power to return the obligation, you may freely command me.

“ I AM afraid I have tired your patience with this long detail, and am, with respect,

SIR,

Your most obliged,

And most obedient servant,

JOHN BRAY.”

N^o IV.

THE passage in *Van Swieten*, referred to in the note, page 171, is as follows:

“ *Ætius* dum lac deficeret in Nutrice, *Zythum* propinari jussit; dixitque: *Eodem die Ubera lacte replebuntur. Mulieri autem videbitur, ubi poculum acceperit, omnibus membris languescere & exsolvī, donec lac in Mamillis collectum fuerit. Debet autem talis cerevisia meracior nondum per fermentationem temulentam*

mulentam vinum acquisivisse; tunc enim for-
titer inebriat. In pluribus lactantibus egre-
gium talis cerevisia effectum vidi; & qui-
dem in propria uxore; quæ, dum infantibus
suis daret ubera, lectum petens, hujus ce-
revisiæ libram sumxit, hoc cum effectu, ut
tota nocte ubera lacte plena haberet.

NO V.

The following is taken from the *London Magazine* for September, 1764. I thought it very well worth the preserving, and have inserted it here, to the end that people may be instructed in the method of preparing a remedy for the scurvy, which may be conveniently carried to sea, and is known from repeated experience to be very powerful in its effects.

To the AUTHOR of the *London Magazine*.

S I R,

“ I CANNOT refrain from communicat-
ing, through your useful magazine, to the
public, the experiences of a worthy friend
lately deceased, Mr. Peter Kinwood, of
Tappsham, in Devonshire (who had been ma-

ny years in the sea-service, and continued to his death to be concerned in (shipping) in regard to the utility of a cheap and easily prepared drink, called by him *Chowder-Beer*, for preventing the scurvy in long voyages, or for the cure of it where it may have been contracted. Perhaps the term of *Chowder-Beer* may be a provincial phrase, known only in *Devonshire*: But the following instructions for brewing a drink of black spruce fir, with melasses, will explain the thing to every one's understanding; as I hope the account given of its utility will introduce it to general knowledge and use. The following account I give you verbatim, as transmitted to me by my friend; who, in all his actions, was animated by a prevailing love and desire to improve every talent committed to him, for the most extensive benefit of mankind. I am,

S I R,

LONDON,
Sept. 13, 1764.

Your very humble servant,

A MERCHANT."

“DRY spruce, if boiled in water about one hour and half, will make good *Chowder-*
der-

der-Beer. I think it the wholsomeſt drink that is made; I am ſeldom without it when I can get ſpruce. When I lived in *New-England*, I had a veſſel that went from thence to the *West-Indies*, and the bay of *Honduras*, for logwood: I always charged the maſter of her to take black ſpruce with him, and give his men beer all the voyage, which he did, and his men were healthy and well in the *West-Indies* and in the Bay, when others, at the ſame time and places, that drank water, were very ſickly. I have ſo great an opinion of the beer, that I wiſh it was uſed in all our ſhips on the coaſt of *Guinea*, and in the *West-Indies*; and where at many places the water is very bad, which if brewed into this beer, by the fermentation, would likely make it good drink, and with the help of the ſpruce nothing ſo eaſy to make. I ſuppoſe in the hot countries they need not boil but about one-third, or a quarter part of the water, but enough to mix with the cold water, ſo as to warm it fit for fermentation: It fines, and is fit to uſe very ſoon. The ſpruce may be kept in any dry place good, for two or three years after cut. In the *West-Indies* the melaffes is plenty, ſo that the beer would coſt but a trifle.

trifle. I heartily wish that encouragement was given for planting these black spruce trees. I think it is the best wood of all the fir kind, very good for ships topmasts, and other service in ships. 'Tis a fine beautiful ever-green tree with a fine top: They grow in poor land, that at many places has little depth of soil; at *Newfoundland* and in *New England*, a hard rocky bottom, that the roots go but little under the earth or moss, so that knees are often made of one part of the root, and the other of the stock or body of the tree, and are put into ships built at *Newfoundland*; I have seen them used in ships here also: The spruce trees in the woods commonly grow near together, and run up 25 to 30 feet long, without any considerable knots. The Scots firs that I have seen here are small, and the timber grows in a circle round the trees, so that they are apt to break off there. The black spruce is a very tough durable wood. If spruce beer was generally made use of in the *West-Indies*, those ships that go there from *Newfoundland* and *New England* would likely carry what spruce they could with them, if they found a sale for it: And for after-ages it may be had in any part of *Britain*,

rain, if care is taken to propagate it, which I humbly presume would be of great service to the poor sailors and others. The kettles that ships have for their service would do to brew for most common merchant ships, as in hot countries they need only to boil a small part of the water, but fill the cask mostly with cold water. It would be well some better kettles were found than copper, as at times boiling salt victuals in them they are nasty, and I fear hurtful in boiling clear peas for the men; green poisonous matter hanging about them. The sea-cooks are not cleanly, and in stormy weather it is a troublesome office: If some thin iron kettles could be made, it might be much better.

“ I MAKE no doubt it may be carried to the *East-Indies*, and used there to good effect, as a preserver of health. Before the use of this beer was found at *Newfoundland*, the men were sickly, scorbutic, &c. but now no country where they are more healthy. I have heard a gentleman say, that now, when it has happened they had not the *Chowder-Beer*, for want of melasses, to drink, they would be sick. I cannot but think it must be very beneficial to the sailors

lors in general, who, after they leave this country, likely the beer they carry from hence is expended in six weeks or two months: After that, if their voyage is twelve months or more, water is their common drink, which if good it might be tolerable; but at many places it is very bad, and at times, at sea, stinks much in the casks. The beer that is carried to sea from hence seldom is racked; so that by the motion of the ships, after it is a little time in draught, it is very indifferent drink.

“ I HAVE been told by a gentleman that has put fir seed into the ground, that great care must be taken to cover it with a net, or some other thing, else the birds would eat it as soon as it appears out of the ground.

“ IF spruce beer should be used in the merchants service, and found to be salutary, no doubt they would also use it in the navy. It is a fine thing that the black spruce should, after so many years being cut, retain that good quality in it of making good *Chowder-Beer*; here are some persons that have lived in *Newfoundland*, and know the service it is to people in drinking it.

The

The Method of Preparation of Chowder-Beer.

“ TAKE twelve gallons of water, and put therein three pounds and an half of black spruce. Boil it for three hours; then take out the fir, and put to the liquor seven pounds of melasses, and just boil it up. Then take it off, strain it through a sieve, and, when milk-warm, put to it about four spoonfuls of yeast to work it.

“ FOR common drink for seamen two gallons of melasses may be sufficient to an hoghead of liquor. It soon works. In two or three days stop the bung in the cask, and in five or six days, when fine, bottle it for drinking.

“ WHERE the spruce is green and plenty, they boil it but about three quarters of an hour, so as that the bark will strip off from the branches by drawing through the hand. They never strain the spruce, but fill the cask, one-half or two-thirds full of cold water, on about a pint or more of the grounds of the *Chowder* drank out of the cask. After taking the spruce out of the kettle without straining it, put the melasses into the kettle: Make it just boil up, and fill it into the cask; and the grounds of
the

the *Chowder* left in before will soon work it. If the hot water will not fill the cask, fill it up with cold. No need of coolers to cool the liquor as in other beer. It drinks as well when one-half or two-thirds of the water is cold, as when you boil more of it. In the *West-Indies* they need boil but a trifle of the water, just enough to get the bitter out of the spruce. And two and an half gallons of molasses will make a hoghead of tolerable good drink. Good *West-India* molasses make better drink than treacle or coarse sugar: Though in the want of the former either of the others may serve."

Nº VI.

I FIND from Dr. *Nathaniel Hulme's* *disfert. inaug. de scorbuto*, that the *cortex*, joined to the acid juices, has been used at sea with great success.

Mr. *Hodgkin*, a surgeon in the royal navy, was the first who introduced this practice. The method is to give a drachm of the *cortex* in powder, with an ounce of lemon or orange juice, three times a-day; and night and morning the swelled limbs are to be bathed in vinegar. This course
is

is to be persisted in, until the scorbutic symptoms disappear : the belly all the while being kept open by gentle laxatives.

Dr. *Hulme* (who was also a navy surgeon) says, that he sometimes found the cortex in powder to disagree with the patients, by creating a great difficulty of breathing : in such cases he used a tincture instead of the powder, and then found that this uneasiness did not succeed. The tincture was made by digesting two ounces and a half of the cortex, and half an ounce of myrrh, in a pint of brandy. Half an ounce of this, mixed with an ounce of the acid juice, was the usual dose.

it is to be preferred in cases of the kind
symptoms of the disease: the following the whole
being kept open by gentle laxatives.
Dr. Fisher (who was also a very sagacious)
says that he sometimes found the cortex in
patients to disagree with the patient, by
causing a great difficulty of breathing: in
such cases he used a mixture of the
powder and rose-leaf and this usually
was not disagreeable. The mixture was
made by digesting two ounces and a half of
the cortex and half an ounce of water
in a pint of spirit. Half a ounce of
the powder was added to the spirit and
the mixture was the usual dose.

ESSAY V.

ON THE

DISSOLVENT POWER

OF

QUICK-LIME, &c.

Q

*There are agents in nature able to make the
particles of bodies stick together by very
strong attractions; and it is the business of
experimental philosophy to find them out.*

NEWTON.

ESSAY V.

ON THE DISSOLVENT POWER of QUICK-LIME.

THE experiments of the second and third essays have sufficiently shewn, that the cohesion of animal and vegetable substances depends *immediately* on the presence of the *fixed air*; but how far the influence of this principle extends into the mineral kingdom, is not yet certainly known.

HALLER seems to think that it is very general, being here also the *vinculum*, or *gluten verum moleculis terreis adunandis**; though it does not appear that he has any actual experiment of his own to confirm this hypothesis.

BUT since the publication of Dr. Black's most ingenious paper on the *magnesia*, we

* *Prim. lin. sect. 244.*

cannot help being convinced that the theory holds good, at least with regard to the class of bodies which he hath examined; to wit, the calcareous earths.

THE reader may remember, that the doctor's theory of calcareous earths is, that these bodies have a very strong degree of affinity * with fixed air, and, in a natural state, are replete with it; that by calcination they are deprived of this element, and hence become caustic and soluble in water; but that, upon restoring the fixed air, they are again rendered mild and insoluble.

ALL this is very satisfactorily shewn in the essay above mentioned: but it occurred to me, that it might possibly be still further proved, and that in a way which would afford an ocular demonstration. I thought that perhaps the dissolved quick-lime might be rendered visible, and would precipitate on transferring *fixed air* into *lime-water* †.

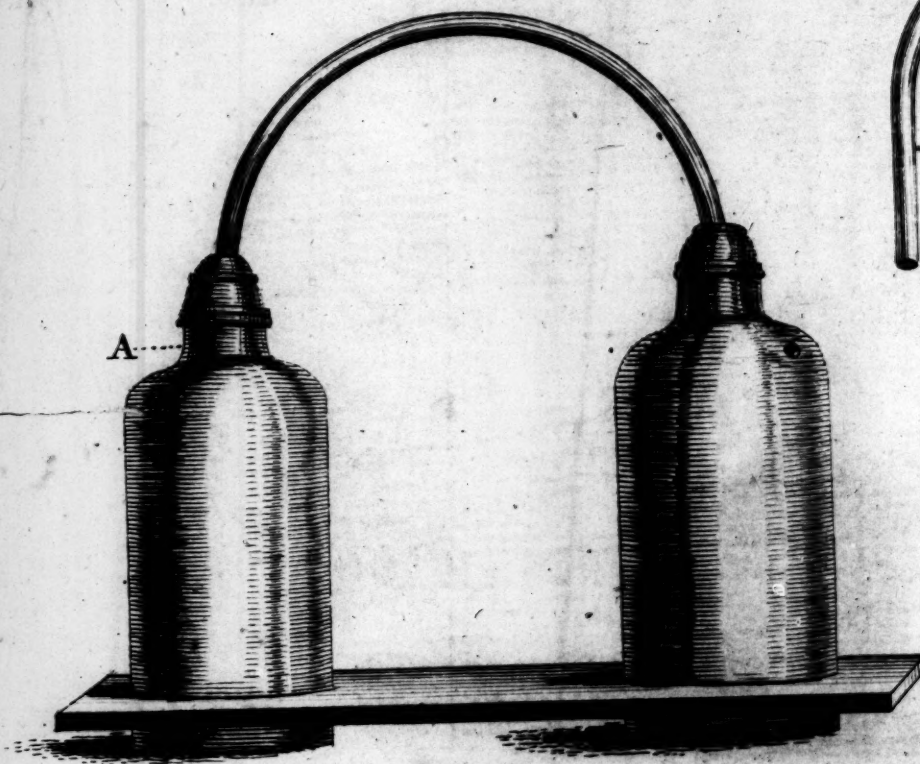
EXPE-

* And fixed air has a stronger affinity with calcareous earth than with any other substance yet known.

† In the manner described in the second essay.

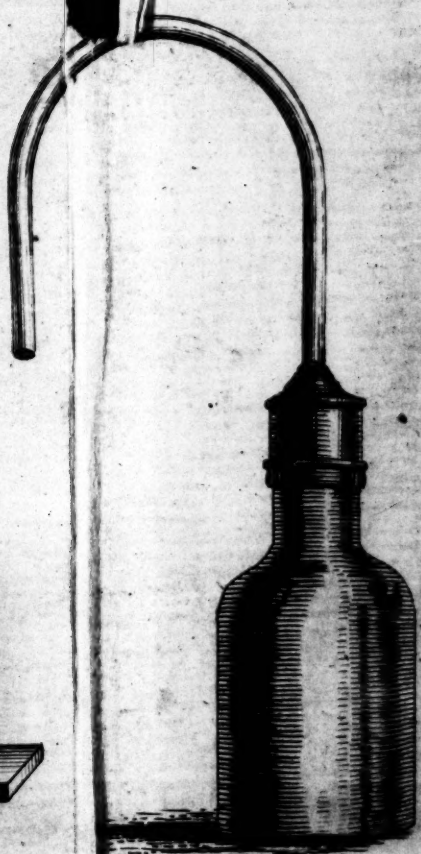
When I found that by transferring air into different bodies, a variety of curious changes were produced, I laid aside the glass tube, and had an apparatus prepared which

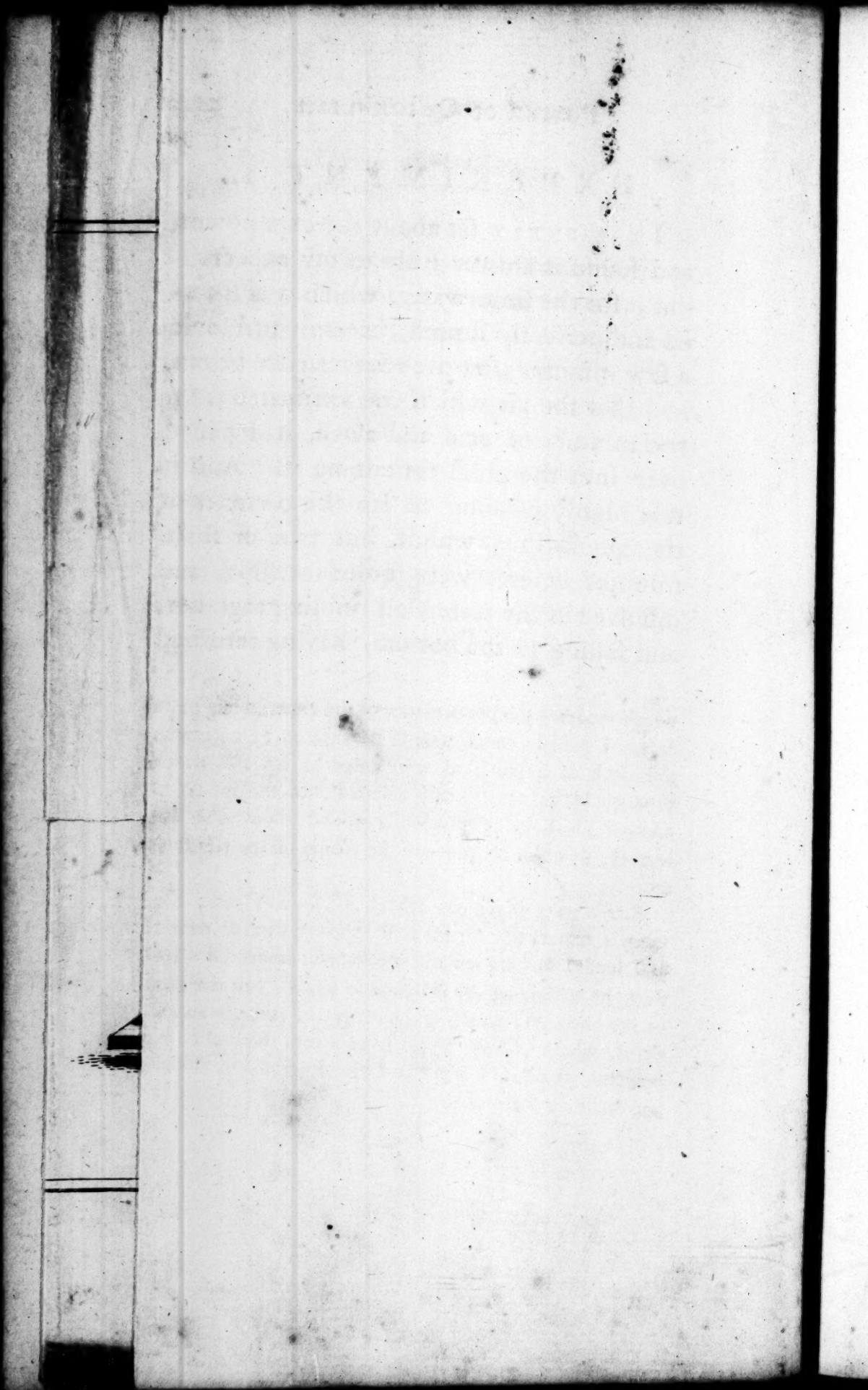
Fig. 5.



facing p. 229.

Fig. 4.





EXPERIMENT I.

I PRESENTLY set about the experiment, and found it answer fully to my expectations; for the lime-water, which was filtered and perfectly limpid, became turbid in a few minutes after the effervescence began, and that the air which was extricated from the mixture of acid and alcali, had passed over into the phial containing it. And it was highly pleasing to see the particles of the quick-lime, which, but two or three minutes before, were quite invifible, and dissolved in the water, all running together, and falling to the bottom, having returned

which rendered the performance of the experiments more easy. I caused a metal tube to be fixed on by a screw to the neck of a phial, as represented in fig. IV. which tube could be occasionally inserted into the mouth of another phial, being previously wound about with soft leather, in order to prevent the escape of the factitious air.

But a very ingenious friend, *William Deane*, Esq; who is remarkable for his skill in every part of natural philosophy, but particularly mechanics, improved it further, by contriving the machine in fig. V. In the neck of the bottle A, which is the recipient, there is an *air-valve*, which allows the air to pass into the bottle, but prevents its return; and this I found greatly to shorten and facilitate the process.

to their original state of insolubility, the moment they were saturated with the fixed air.

WHEN the turbid mixture had stood long enough to allow the precipitate all to subside, I poured off the clear, and found some grains of calcareous earth, which effervesced violently with spirit of vitriol.

AND thus was the theory of Dr. Black placed beyond the reach of contradiction; since we must here be convinced from what is seen to pass before our eyes, that the quick-lime became *soluble* in water from the want of its fixed air, because we find it grow *insoluble* the moment the *cementing principle* is restored.

FINDING, by the preceding experiment, that the lime, though so minutely divided, and so intimately mixed with the water, as to be reduced to a state of actual fluidity, might nevertheless be rendered solid, and brought immediately into view, by restoring the cementing principle, I began to think, that the sulphur in the natural sulphureous waters might also be rendered visible, by introducing air into them in like manner, as I had done into the lime-water.

BUT

BUT as I could not immediately procure a natural sulphureous water, I resolved to try the experiment with an artificial one.

EXPERIMENT 2.

IN order to do this, I boiled up some flowers of sulphur with water and quick-lime (as directed for preparing the *sulphur præcipitatum*;) and having filtered the solution, I put about four ounces of it into the phial used in the foregoing experiment, and transferred the air from an effervescent mixture contained in the other phial.

THE sulphureous did not so soon lose its transparency as the lime-water, but, in eight or ten minutes, a scum formed on the surface; and the whole solution immediately after becoming turbid, I could plainly perceive the solid particles collecting themselves together.

WHEN I thought that there was a sufficient quantity of air thrown in, the phials were separated, and the turbid contents of the first one poured into a tall drinking-glass. The liquor now sent forth the strong and peculiar smell which solutions of sulphur always yield, when an acid is added to them.

EXPERIMENT 3.

HAVING soon after got some bottles of the *Lucan* * water, a few ounces of it were put into the phial, and air transferred from an effervescent mixture, as in the two preceding experiments; but notwithstanding a slight degree of milkiness appeared at first, yet no precipitation ensued.

THESE experiments, however, pointed out a method of making a pure solution of sulphur, which being diluted to the proper degree, gives an artificial sulphureous water, perfectly resembling the natural, as to taste, smell, transparency, and want of colour, and not liable to grow turbid on the addition of acids, which all other artificial solutions of sulphur, hitherto known, constantly do.

* A village within six miles of *Dublin*, and the seat of *Agmondesham Vesey*, Esq; in whose gardens there is a spring of sulphureous water; the spring breaks out so close to the side of the *Liffy*, that it was constantly overflowed upon every rising of the river, and constantly was lost to the public, until the proprietor not only caused the well to be inclosed at a considerable expence, but also laid open a free passage to it through his very elegant improvements.

E X P E R I M E N T 4.

THE turbid solution of lime and sulphur, as hath been already mentioned, was poured into a tall glass, and happening not to be thrown out, I found after standing thirty-six hours, that it did not become limpid, though I could plainly perceive a quantity of lime lying at the bottom, while the yellowish fluid remaining above, evidently shewed to be an equable and true solution of sulphur, now left perfectly alone in the water: * I immediately saw that there was nothing more to be done here than to dilute this solution to a proper degree, and that it would then constitute a true sulphureous water.

UPON trial, it actually did so; and although this present solution, from being so long exposed to the open air, had lost much of the strong and peculiar sulphureous smell, yet I found, on repeating the experiment, that a solution, fresh made, and the lime, immediately separated from it by the intro-

* *Sulphur* was formerly thought to be possessed of great virtues: If any one should now be desirous of trying it, here is a method shewn whereby it may easily be exhibited in pure solution.

duction

duction of air, and then diluted, so as to leave the liquor colourless and transparent, yielded a water so nearly resembling the natural, that, as to smell, taste, or appearance, it was hard to perceive any difference.

BUT upon dropping *lixivium tartari* into the artificial water, it instantly grows turbid; * whereas, when the like addition is made to the natural sulphureous waters, their brightness is improved; which shews that the solution of sulphur, in the natural waters, is brought about in some manner not analogous to that in the artificial; for it seems pretty obvious, that the sulphur is here rendered soluble in water, from being deprived of its *cementing principle* by that share of the quick-lime which remains undissolved in the boiling.

THIS consideration presented a new theory concerning the solubility of oil, when combined with the caustic alkali, and made into soap; which, I conjectured,

* On mixing the fixed alkali, the peculiar sulphureous smell is instantly changed to one which is rather more disagreeable, and though the mixture becomes turbid, yet no precipitation ensues; the sulphur and the alkali, joining into a sort of thick cloud, remain suspended in the middle of the glass.

might,

might, as well as the sulphur, be rendered soluble in water, because the cohesion of the oily particles is destroyed, from the loss of their fixed air, which is absorbed by the caustic lixivium.

EXPERIMENT 5.

THIS conjecture was found to be right, by transferring air, from an effervescent mixture, into a solution of common soap; for the moment the air mixed with the solution, the oily part began to separate, and, in a few minutes, all rose to the surface, the cementing principle now being restored to the disunited particles of the oil.

I REPEATED this experiment on a solution of soap, which was filtered, and kept above a week after it was made; so that there could be nothing of a spontaneous separation in either case.

IF the reader be well acquainted with Dr. Black's theory, he can be at no great loss in accounting for the manner in which common soap lees come to acquire the caustic quality; but if he has not seen the paper on *Magnesia*, it will be necessary to inform him, that when quick-lime is added to a lixivium of pot-ash, or kelp, it ab-

sorbs

forbs the fixed air from these salts ; but the particles of lime, by this absorption, becoming incapable of solution, fall to the bottom, and leave the saline particles alone in the lixivium, and deprived of their fixed air : The lixivium now becomes a powerful absorbent of fixed air, and will attract this principle from any animal or vegetable substance to which it may chance to be applied ; hence of course it becomes a caustic, by corroding and destroying the texture of these substances, whose soundness and perfect cohesion depend on the presence of the fixed air.

By adverting to this theory of the caustic alkali, we may perhaps be enabled to speak intelligibly concerning that dissolution of the blood which arises from a putrefactive acrimony ; and may form some idea of the manner in which it may be restored to a state of soundness, from being supplied with a sufficient quantity of fixed air.

In the composition called Soap, we see, that the particles of caustic alkali, on account of their powerful attraction or affinity with fixed air, absorb this principle from the oily particles, destroy their cohesion,

sion, and thus render them soluble in water.

Now chemistry shews, that the blood consists of oily, earthy, saline, and aerial particles, dissolved and mixed in a watery fluid.

I SAY dissolved and mixed, for the oily, earthy, saline, and aerial particles appear to be held partly in a state of mixture, and partly in a state of dissolution.

IT is through the intervention of the *saline* particles, that the *earthy* and the *oily* come to be intimately united with, and in some measure dissolved by the *watery* part of the blood; but as the aerial particles (whose proper use is to produce cohesion) prevent a *total* dissolution of the *earth* and the *oil*, the blood, and most other animal fluids, while in a sound state, have a certain degree of tenacity, and feel smooth and mucilaginous; but when an unusual proportion of the *fixed air* is detached and withdrawn from these fluids, their *saline* part is *then* left in a *caustic* state, which will *now* join *closely* to the *oily* part, and with it form a compound which will *totally* dissolve in the aqueous part, and thus ren-

der acrid, and thin, the fluid that before was smooth, mild, and tenacious.

If to a fluid thus dissolved the fixed air be sufficiently applied, the tenacity and consistence of that fluid will be restored, in the same manner as the particles of oil were seen to recover themselves, on air's being transferred into solutions of soap.

THE foregoing experiments opened the way to some improvements in *pharmacy*; since it followed plainly, that if oil may be rendered soluble in water, by depriving it of the fixed air, *camphor*, and all kinds of *resinous bodies*, may, on the same principle, be dissolved *.

* Until within a few days before these papers were sent to the press, I looked on the method of dissolving resinous bodies by the means of quick-lime, as a discovery, not having observed, when I first read Dr. *Lewis's Materia Medica*, that its dissolvent power, with respect to these substances, is known to that ingenious and useful writer. The passage relating to this matter is under the head of *calx viva*, and runs in the following words.

“ Lime-water dissolves, by the assistance of heat,
 “ mineral sulphur, vegetable oils and resins, and animal fats; it extracts in the cold the virtues of sundry
 “ resinous and oily vegetables, and dissolves thick
 “ phlegm, or mucous matters, and the curd of milk,
 “ with which last it forms a white liquid, nearly similar to milk in its natural state.”

EXPERIMENT 6.

I BEGAN with the camphor, and having rubbed a drachm of it with an equal portion of quick-lime, and then poured on six ounces of lime-water, I allowed the mixture to stand for half an hour, that the gross and insoluble part might subside; the clear was then passed through a filter, and found to be a strong solution.

ON another occasion, I made use of heat, boiling the camphor and quick-lime with water in a close vessel, and thus obtained a much stronger solution.

THESE solutions, when filtered, are perfectly limpid, and never part with the camphor; for though the lime may be precipitated in several ways, yet I have not hitherto hit upon any method of separating the camphor from the water*.

EXPERIMENT 7.

MYRRH, *gum guaiacum*, *asa fætida*, *aloes*, *castor*, *balsam of Tolu*, with *masticb*, *jalep*;

* I have now [12th December, 1766] some of this solution of camphor, which has been lying in a phial, not closely stopp'd, for three years; and yet it is still perfectly transparent, and exceedingly strong.

and

and the *cortex*, were all tried in the same manner as the *camphor*, and were found to yield strong solutions and tinctures; the lime enabling the water to take up the same part of these substances that may be dissolved by the means of ardent spirit. But these aqueous tinctures must be much more elegant medicines, and perhaps may be found more efficacious than the spirituous, since they will never become turbid, or separate, on being mixed in any watery vehicle.

THERE is as much lime in all these tinctures and solutions, as there would be in the like quantity of lime-water, which bids fair to improve the virtues of some of them, and can do no great injury that I know of to any; but if it should ever be thought to do so, the lime may be precipitated by throwing in air from some effervescent mixture, as hath been already explained.

THE air, when thus thrown in, renders the solution, or tincture, quite turbid, and appears plainly to the eye at first, to reunite the dissolved particles of the resin, as well as the lime; but the former are very
soon

soon redissolved, and the lime only falls to the bottom.

BUT as this process may be thought troublesome, a solution may be made (not indeed so strong as those above-mentioned) in which there shall not be a particle of lime: as for instance with regard to camphor.

Take of camphor one drachm;

———— double refined sugar one drachm;

———— simple lime water one pint.

RUB the camphor and the sugar together into a fine powder, and then gradually pour on the lime-water; let the whole stand for two hours, and then pass the liquor through a filter. And thus will be produced, a much stronger solution than that in the common *julepum camphoratum*.

IN the common way of making *julepum e moscho* (as directed in the London Dispensatory) scarce any of the *musk* is dissolved; but if it be made in lime-water, a perfect solution of the finer and more active part of the medicine will immediately take place.

Take of musk one scruple;

———— double-refined sugar one drachm;

———— lime-water six ounces;

R

RUB

RUB the musk and the fugar together, then add the lime-water, and filter, as before directed.

TO this, as well as to the foregoing, the prescriber may add any spirituous water, or the volatile alkaline spirits, without destroying the transparency of the solution.

IF an acid spirit be poured upon what is left on the filter, after either of the foregoing solutions, it will be found to raise a smart ebullition; which plainly shews that the quick-lime that was dissolved in the water is now saturated, and rendered solid, by the *cementing principle*, and has changed places with part of the camphor and musk, which remains dissolved in the water, while the lime is precipitated.

BUT there are cases wherein the lime will bid fair to improve the virtues of the resinous solutions; as for instance, when the *cortex* is prescribed merely with a view to its astringent quality, as in scrophulous and relaxed habits, in order to check or dry up ulcers, gleet, or uterine discharges; and here it may be ordered in the following manner:

Take of Peruvian bark, in powder, two
ounces;

Take

Take of quick-lime one ounce;
—lime-water thirty ounces;

Rub the bark and the lime together, until they be thoroughly mixed; then gradually pour on the lime-water; let the whole stand for twelve hours, and then pass the liquor through a filter.

AND thus will be obtained a most elegant, and not unpalatable tincture, which may be taken, either quite alone, or in any convenient vehicle, and in what quantity the prescriber shall judge proper.

I CAN venture to assure the reader, from repeated experience, that the bark, given in this manner, and in the cases abovementioned, will scarce ever fail; particularly, with regard to the uterine discharges, when they proceed from mere relaxation and weakness. And where a yet stronger astringent is required, oak-bark, managed in like manner, has been found to answer exceedingly well.

RHUBARB, prepared in the same manner, yields a beautiful tincture, which hath been found of great service in all cases where small quantities of this root are given with a view to strengthen the bowels, and to preserve them free from a load of

viscid slime, as in weak and ricketty children; and in cases, where it is suspected that the mesentric glands are stuffed up and obstructed.

ALOES, when joined with the lime, is not near so nauseous as when dissolved in the common way; and therefore, independent of the lime, whose virtues as an anthelmintic are considerable, bids fair to be of great use; for children, who generally are the patients in these cases, will probably be induced to take the medicine better when thus made up, than when it is prepared in the usual manner.

MYRRH and *saffron* may be occasionally joined with *aloes*; and being all dissolved by the means of quick-lime, will make an efficacious *elixir proprietatis*, as the lime will certainly improve the virtues of the other ingredients, in most cases where a composition of this sort may be ordered to advantage.

GUM GUAIAECUM may be dissolved with great ease, in the manner we are now speaking of, being rubbed up with an equal quantity of quick-lime, and afterwards mixed with the requisite proportion of lime-water. This solution, as it mixes so completely

completely with any watery vehicle, can be much easier taken, and perhaps may be found a more powerful medicine, in cold rheumatic complaints, than the common tinctures : *Castor* answers exceedingly well, given in this manner, and may be taken in large doses, without offending the stomach.

Two drachms of *castor*, rubbed up with a drachm of quick-lime, and mixed with six ounces of lime-water, give a strong and elegant tincture, which may be flavoured by adding nutmeg-water, or any other of the like sort, and then given in such doses as shall be thought convenient.

It will, no doubt, be reckoned superfluous, that *lime-water* is ordered to be added to these several substances, when they are also to be rubbed along with *quick-lime*; but the reason is this : If the lime were so quick and fresh as to raise heat when common water is poured on it, the solution might then be made without the aid of lime-water ; but as it will, for the most part, happen that the lime kept in the shops shall not be perfectly fresh, it will be best that the prescriber should direct lime-water to be used, in order to be

secure of the solution, which would not be so completely made, nor so much of the resinous substance be dissolved, if *slaked lime* and *common water* only were made use of.

AND it is much the same thing in the end, with regard to the proportion of lime in the solution; for although lime-water may receive some additional strength, from being poured repeatedly on fresh quicklime, yet here the quantity acquired must be so very inconsiderable as not to be worthy of notice.

As the fixed air, when thrown off by putrefaction, or during the first stage of fermentation, equally produced the effect, of rendering *mild* the *caustic* alkali, with that which was set free by effervescence; it might have been fairly concluded, that it would also precipitate the lime from lime-water; but as I had laid it down for a rule to depart as little as possible from actual experiment, and to be very sparing in drawing conclusions from any thing but evident facts, I determined to make the trial.

EXPERIMENT 8.

ACCORDINGLY, having joined two phials together, by means of the bended glass tube, (as in the 16th experiment of the second essay), and filled one with fresh mutton, and a little water to make it putrefy the sooner, and the other with lime-water, I laid them by in order to let the putrefaction proceed.

BEFORE twenty-four hours were elapsed, the precipitation of the lime was evident, and it increased every day, for six days that the phials remained in this situation; but shaking the phials one day, in order to make the putrid liquor subside (for it rose in the tube in the same way that it did in the experiment before-mentioned, when I was transferring air from putrid flesh into the caustic alkali) the tube happened to break, and an end was thereby put to the experiment; but I had seen enough to prove that *fixed air*, when thrown off by *putrefaction*, would produce the very same effect on lime-water with that which was set free by *effervescence*.

AND here we have an additional proof of the *fixed air's* being the *cementing prin-*

ciple in animal substances; since we see, that while the flesh is resolved, and falls in pieces, from the loss of this principle, the lime is rendered solid by having it restored.

WHILE this experiment, and the following, were going on, I filled two phials with filtered lime-water (that used in the experiments was always filtered) and left one of them without a cork, while the other was closely stopped, and laid them by as standards; to see if any of the lime would precipitate when left to itself: But neither the one, nor the other, in a fortnight's time, deposited the smallest particle of lime.

EXPERIMENT 9.

IN order to try the effects of the *gas*, or vapour, discharged during the first stage of fermentation, I made up six ounces of a fermentative mixture, of flesh meat, bread, cabbage, and turneps, with the requisite quantity of water, and put it into one phial; which being joined, by means of the tube, to another filled with lime-water, the two were placed in a temperate degree of heat, that the mixture might ferment the sooner.

THE

THE fermentation began in the usual time, and went on with the common appearances: And as it did proceed, the lime became every day more and more visible; and forming, first, like flakes of a feathered resemblance, near the surface, these gradually fell to the bottom, until, at the end of five days (the period that the phials remained in conjunction) when I poured out the water, and allowed the precipitate all to subside, I collected three grains of calcareous earth from six ounces of lime-water, which was the quantity contained in the phial.

THIS action of the vapour (which has on former occasions been termed antiseptic) in re-uniting the dissolved and scattered particles of lime, may serve to give some idea of the manner of its operation on dissolved blood, when the texture of that fluid is destroyed and broken, by a putrefactive acrimony.

THIS experiment likewise shews, that lime-water must lose part of its virtue, from the fixed air of the alimentary substances saturating and rendering inert, the dissolved and active particles of the quicklime; and, therefore, when given as a

lit bon-

Ecthontriptic, ought not to be drunk, but when the stomach is empty.

THE activity of lime-water must also be impaired by infusing vegetable substances therein, which contain much fixed air; such as the *guaiacum*, or *sassafras*; for these woods abounding in resin, give out their cementing principle, which, uniting with the dissolved quick-lime, restores it to its original state of an inactive calcareous earth: Therefore, when it is intended that these woods, or any other substance of the like nature, should give out their virtue to lime-water, and that the water should, at the same time, contain its due proportion of dissolved lime, some quick-lime ought to be added, during the time of maceration.

We have seen, then, in *three* different instances, that the lime is precipitated from lime-water by restoring to it the fixed air: May not lime-water, therefore, upon this principle, be used as a *test* to try whether or not bodies contain *fixed air*? If any body, upon mixture with lime-water, occasions a precipitation, and if the precipitate so caused effervesce with acids, may we not conclude that the body so added contains fixed air; and that, in a greater or smaller

POWER of QUICK-LIME. 251

smaller proportion, as the precipitation of the lime from the water is more or less immediate?

EXPERIMENT 10.

SPIRITUS cornu cervi per se, salt of hartshorn, and salt of tartar, being severally mixed with lime-water, immediately threw down a precipitate, which, upon examination, was found to be true calcareous earth.

EXPERIMENT 11.

SPIRIT of sal ammoniac, made with quick-lime, and the caustic alkaline ley, made of potash and quick-lime, when mixed with the lime-water, did, neither of them, in the least destroy its transparency, nor did any precipitation ever ensue.

EXPERIMENT 12.

BUT air being transferred into the same caustic alkalies, and lime-water then mixed with them, the same appearances followed which happened on mixing the mild alkalies in the 10th experiment.

EX-

EXPERIMENT 13.

BROWN sugar, when mixed with lime-water, presently threw down a precipitate, which effervesced violently on the addition of spirit of vitriol; but refined sugar (which is deprived of great share of its fixed air, by the quick-lime that is used in refining it) when dissolved in lime-water, did not at all destroy its transparency, and, after standing twenty-four hours, threw down scarce any precipitate.

EXPERIMENT 14.

RECENT juices of fruits, when mixed with lime-water, destroyed its brightness immediately, and soon after threw down a precipitate, which effervesced violently on the addition of spirit of vitriol. But fermented liquors occasioned no immediate change, nor did any precipitation ensue until after several hours standing, and this different in different liquors: * Then, also, the quantity of precipitate was but small, the whole of the lime not being saturated,

* Cyder and bottled beer threw down the precipitate much sooner than claret or port-wine.

as the taste plainly testified was done by the recent, unfermented juices.

EXPERIMENT 15.

ARDENT spirits* produced still less alteration on lime-water, than the fermented liquors; but they absorbed the air from an effervescent mixture very readily, and, when thus charged, threw down the lime from the lime-water instantly on being mixed therewith.

THESE experiments all concurring to establish lime-water as a *test* of the presence, or absence, of fixed air, I resolved to examine some of the animal fluids, in this manner.

IN Dr. *Whytt's* very ingenious essay on the virtues of lime-water, we find a number of experiments, made with a view of determining what things impair or destroy its dissolvent power, with regard to the *calculus*; one of which plainly shews, that the urine contains fixed air; for when this celebrated professor mixed "an ounce and a half of lime-water, and an ounce of fresh made-urine, it immediately lost its

* It was rectified spirit that was tried.

yellow

yellow colour, and became whitish and turbid, and, in a little time, a light, white sediment fell to the bottom, and left the liquor above perfectly pellucid, of a fine light lemon colour, without any scum or crust on the sides of the glass*.

EXPERIMENT 16.

I REPEATED this experiment with precisely the same appearances; and found, that on pouring off the clear, and dropping in spirit of vitriol, a violent effervescence ensued; plainly shewing, that the particles of the quick-lime, now saturated with the fixed air, which they had absorbed from the urine, were returned to their original state of a calcareous earth.

WE have already hinted, that there is some danger of lime-water's being deprived of part of its virtue, from the vapour arising from the alimentary substances, during their fermentation in the first passages; and here we have another circumstance which is discouraging, with regard to the dissolution of the *calculus*.

By the experiments hitherto made, the *calculus* appears capable of dissolution in two

* See the Essay, sect. 2. No. 8.

ways;

ways *; either by means of a strong acid, such as spirit of nitre, which acts immediately on the earthy part of the stones or by lime-water, or caustic alkali, absorbing the fixed air; whence, the earthy parts deprived of what bound them together, must presently fall to pieces †.

WITH regard to internal exhibition, the acid is entirely out of the question, and the only hope of a safe dissolvent must rest on the caustic alkali, or on the lime-water.

THIS alkali, when combined with oil, and made into soap, is not only so greatly obtunded thereby as to lose much of its power, but the soap itself is so nauseous, that few patients can bring themselves to take it in a quantity sufficient to prove of much effect; it would therefore be a happy discovery if any vehicle could be found

* In the *Mém. de l'Acad. R.* for the year 1720, there is a paper, and a number of experiments, concerning the dissolution of the calculus. Common hard well water dissolves some kinds of calculi.

† Of all the various substances examined by Dr. Hales, with a view of determining their respective quantities of air, the human calculus was found to contain the largest proportion; above one-half of this mass consisting of fixed air.

out,

out, that would properly sheath the acrimony of the caustic alkali, so as to allow it to be taken in large and continued doses: Possibly veal broth *, or a decoction of marsh-mallow roots, might be found to answer this purpose; and lime-water might be taken at the same time, which would not at all interfere with the operation of the alkali, but rather add to its activity.

For lime-water, when taken alone, must often fail in producing any considerable effects as a *lithontriptic*, because it will lose much of its power, not only from the vapour it meets with in the first passages, but likewise from the fixed air of the urine itself, which will saturate great share of the

* There is a paper in the Gentleman's Magazine for October 1763, which proves very plainly, that a nostrum, exhibited by one Dr. *Chittick*, and which is found, after a perseverance of some months, actually to dissolve the stone, is nothing more than the caustic alkali, given in veal broth. The patients prepare the broth themselves, and send it to the doctor every day, who returns it with the medicine mixed therein.

[See Mr. *Blackrie's Disquisition on medicines that dissolve the stone*. This gentleman, who it seems was author of the paper above-mentioned, has now traced Dr. *Chittick's* nostrum to its source, and plainly shews it to be what was originally suspected.]

quick-

quick-lime, even when it hath reached the bladder.

EXPERIMENT 17.

THE *perspirable* matter also contains fixed air: Three ounces of filtered lime-water being put into a phial, and a funnel fixed close into the neck of it, I blew in my breath through the funnel; and by the time I had continued so doing for ten or twelve minutes, I found the water growing turbid, and the lime becoming visible.

THIS being a tiresome kind of operation, I desisted, when I had thoroughly satisfied myself that the *perspirable* matter, if thrown in in a sufficient quantity, would saturate all the lime, since even what I had done, was found, upon collecting the precipitate, to have thrown down more than a grain.

I FOUND also that *sweat* contains fixed air, and used the following method of collecting some drachms of this fluid.

EXPERIMENT 18.

HAVING often observed hackney-chairmen sweat so profusely after setting down their fare, that they sweep it off from their

S

bare

bare heads in a full stream with their leathern straps, I took an opportunity one day of collecting about two drachms of sweat, that had been raised in this manner, and having mixed it with six drachms of lime-water, found that the mixture immediately became turbid, and, in a short time, deposited a light sediment, such as was thrown down from the urine, and which effervesced as violently when spirit of vitriol was added.

Thus we see, that the air is thrown off from the fluids by urine, and by perspiration.

But the *saliva* seems as if it contained little or no fixed air; for when Dr. *Whytt* infused a piece of *human calculus*, weighing three grains, in a mixture of *saliva* and lime-water, in the proportion of one of the former to two and a half of the latter, in two days warm digestion, the bit of *calculus* was reduced to one grain and a half*.

THAT is to say, the lime-water having lost scarce any thing of its power, the *calculus* dissolved as readily in a mixture of

* See 4. No. 21.

saliva

saliva and lime-water, as it would have done in lime-water alone, equally dilute; for had the *saliva* abounded in fixed air, which would have saturated the quicklime of the water, its dissolvent power would have been proportionably weakened, as we find it was by mixing fresh vegetable juices, or honey, with lime-water.*

EXPERIMENT 19.

Two drachms of *saliva* being mixed with six drachms of lime-water, the mixture did not grow turbid; but in two hours I found a sediment, which on pouring off the clear, and dropping in (spirit of vitriol) shewed little or no signs of ebullition. Hence I concluded, that this sediment was far less any thing more than the gross part of the *saliva*, which, when left to itself, in a little time deposits a considerable portion of thick and viscid matter.

EXPERIMENT 20.

I THEREFORE resolved to repeat the experiment; and having collected near an

* See Dr. Wynn's Essay, lect. 6 & 7. No. 34, 36, 37, & 38.

ounce of *saliva*, from a person in full health, and suffered it to stand long enough for the thick part to subside, I then mixed two drachms of the clear with six drachms of lime-water, and found it produce no immediate alteration.

BUT two drachms of the same clear *saliva* being put into a small phial, and air transferred into it from an effervescent mixture, and then mixed with six drachms of lime-water, instantly the mixture became turbid, and a large quantity of precipitate, in the form of flakes, fell to the bottom, and effervesced violently when spirit of vitriol was poured on it.

THE first mixture of lime-water and *saliva*, after standing twenty-four hours, was covered with a crust, and found to have deposited but a small quantity of whitish viscid matter, which effervesced but slightly with the acid spirit.

So that the *saliva* naturally contains very little fixed air, but, nevertheless, is a powerful absorbent thereof*.

FROM

* We had a former proof of the affinity between *saliva* and fixed air, in the 11th experiment of the second essay; wherein it was found, that the *saliva*, when intimately mixed with an animal substance, has some degree

FROM another experiment of Dr. *Whytt*'s the bile appears to contain as little fixed air as the *saliva*; for when he immersed a fragment of *calculus*, weighing three grains, in an ounce of cystic bile, and three ounces of oyster-shell lime-water, and kept it in a moderate heat for forty-two hours, he found that near a grain and a half of the substance of the *calculus* was dissolved in the form of thin whitish scales*.

EXPERIMENT 21.

As I could not, at this time, procure any fresh human bile, and excepting it were fresh, and taken from a healthy subject, the experiment would not have been fairly made, I was obliged to try that of a dog: One of these animals being therefore killed, and its gall-bladder taken out, about a drachm and a half of bile was found in the cyst.

gree of antiseptic power; which agrees with the general theory concerning this power, as laid down in the third essay: For *saliva*, being an attracter of fixed air, when mixed with an animal substance, unites itself with the fixed air of that substance, and in this manner restrains, for some little time, the flight of the cementing principle.

* Sect. 4. No. 22.

ONE half of this quantity being mixed with three drachms of lime-water, the mixture remained transparent, and equable, for an hour; it then lost its pellucidity, and gradually deposited a light sediment, of a dark yellow, or rather orange colour. When it had stood twenty-four hours, I passed the mixture through a filter, in order to separate the sediment; which being done, spirit of vitriol was poured on, and found to raise a slight degree of effervescence.

THE other half of the bile was put into a small phial, and air transferred into it from an effervescent mixture, as had been done in regard to the saliva, and then it was mixed with three or four drachms of lime-water.

THERE was very little difference between the appearances of this mixture, and those of the former one: It remained transparent for about the same space of time; and, then, like the other, lost its brightness by degrees, and deposited a sediment, which only differed in regard to the colour, being of a more light yellow. When this sediment was examined, after standing twenty-four hours, it was found to effervesce

vases violently with the acid, whereas the ebullition of the other sediment was but obscure.

FROM these experiments (if the lime-water be a true test) we see, that *bile* contains somewhat more fixed air than *saliva*, and does not absorb this element so powerfully*.

PERHAPS, it is on this circumstance, that the power of these fluids with regard to their dissolving fat or oily matters depends; since they may thus be enabled to absorb the fixed air from the oils exposed to their action, and thereby destroying the bond of union between the oleose particles, render these bodies miscible with water.

THERE is an obvious reason, why the *saliva* should be the more powerful absorbent of the two; for were not the oily part of our food, from its admixture with the *saliva* in mastication, rendered miscible with

* As the *bile*, in a sound state, contains so little fixed air, we immediately see the reason why putrid bile, and the spirit distilled from it, raise little or no ebullition with acids, notwithstanding the other marks of the *alkali* in that fluid. See the *Essai pour servir à l'Histoire de la Putrefaction*, for a number of experiments tending to explain the true nature of the bile.

the watery part, the alimentary mixture could not ferment properly when received into the stomach; the consequence of which would be sickness, nausea, and heart-burning*, from the sharpness of the oil, that would soon become rancid by the mere heat of the place.

BUT when all the discordant parts of the alimentary mixture are blended together, by the dissolvent power of the *saliva*, and further united by the same quality in the *succus gastricus*, *bile*, and *pancreatic juice* (fluids that are found to be of the same nature with the *saliva*) then no separation of oil ensues, but the fermenting motion goes on, kindly and regularly, until new combinations take place, and that every particle of the food is broken and changed.

BUT in some constitutions this absorbent power of the digestive fluids is so greatly weakened (or, in other words, they contain much fixed air, when, in a natural and healthy state, they ought to contain very little) that the food is never thoroughly

* Not the heart-burning attended with acid, but that accompanied with nidorose, eructations.

dissolved,

dissolved, nor its oily part ever completely mixed or subdued; and hence the immediate cause of indigestion, rancidity in the stomach, and extraordinary flatulence.

As a proof of this, it may be observed, that lime-water is an excellent remedy for the complaints just now mentioned; and perhaps the relief which is obtained in these cases from the use of certain medicinal waters may arise, in great measure, from their containing earthy matters void of fixed air, and which have an absorbent power, like what is observable in lime-water.

THESE waters, which may be considered as a kind of natural lime-waters containing a considerable portion of earthy matter *void of fixed air* (like the particles of quick-lime dissolved in lime-water) as soon as they come into contact with bodies containing much of the cementing principle, must necessarily deposit their earth, which by attracting the fixed air acquires solidity, and will form a succession of crusts, or layers; and it is in this manner, that, I think, we may form a plausible theory for petri-

petrification *, and for the crusts that are found in the pipes and vessels containing certain kinds of waters.

THESE

* A Petrification that I have met with, since writing the above, seems to confirm this *hypothesis*.

It is a petrified moss wherein may be observed, very distinctly, the several gradations from absolute stone to the living vegetable; the course of the fibres being every where plain, and easy to be traced. The part of the petrification that lay constantly under water is absolute stone, and is of the calcareous kind, effervescing strongly with acids; in the middle part, which was not so continually exposed to the action of the water, the petrification is incomplete; and at the top, which was always above water, the vegetable is still alive, and in its natural state.

The well from whence this petrification was brought being in the neighbourhood of Dublin, I sent for some bottles of the water, in order to examine it.

On dropping a little of the filtered solution of *pet. ash* into a glass of the petrifying water, it immediately lost its brightness, turned milky, and, in a few hours, deposited a white sediment, which effervesced strongly with spirit of vitriol.

The very same appearances happened when *Lixivium Tartari* was dropt into the petrifying water.

On air being transferred into some ounces of the petrifying water, it lost its brightness, and, in twelve hours, let fall a small quantity of white sediment.

Hence it appeared, that the petrifying water did contain an earthy matter dissolved therein, void of fixed air, which

THESE petrifying waters were formerly condemned, as being apt to create the stone; but later experience has shewn, that the waters which abound most in this earthy matter, and which form the greatest abundance of the crusts above-mentioned, are the most effectual dissolvents of the stone, as is every day experienced with regard to the *Carlsbadt* water in *Bohemia*.

which was capable of resuming the solid form, as soon as the cementing principle was restored.

Vegetable bodies, therefore, by remaining long exposed to the action of such kinds of waters, will have their substance gradually dissolved; because the earthy particles in the water attract the fixed air from the vegetable substance, and the moment they are saturated they acquire solidity, become insoluble, and remain in the places of the vegetable particles, which are melted away.

This change of a vegetable into a fossil substance, seems analogous to the change of iron into copper, which is brought about in no very long space of time, by leaving iron plates in a water that is strongly impregnated with a solution of copper in the vitriolic acid; the superior attraction of the acid to iron causing it to seize this metal, and let go the particles of copper. So, in the case of petrification, fixed air having a stronger affinity with calcareous earth than it has with the vegetable substance, lets go the latter and seizeth on the former.

THE

THE absorbent quality of the *saliva* moreover shews, how apt it must be to lay hold of infectious *miasmata*, which oftentimes are in reality putrid vapours, or fixed air, detached from bodies during putrefaction; and confirms what hath been frequently recommended, namely, to shake off infection*, and prevent the *miasmata* from getting into the mass of fluids by immediate vomiting; and we may likewise see, that the cautions given by authors concerning the swallowing of the *saliva*, while in the places abounding with infectious vapours, are founded in reason.

It will not appear strange that some of the animal fluids should contain so little fixed air, when we find that the *serum* of human blood seems almost void of this element.

* By the precautions taken by Dr. Lind, and by immediate vomiting, "only five persons died, from among more than an hundred, who were severally, and some of them constantly employed, during eighteen months, in various offices about the sick, in *Hälsar* hospital;" where there constantly was a great number of people ill of fevers that were highly infectious. See his *Discourse on Fevers and Infection*, paper 2d, p. 74:

EXPERIMENT 22.

HAVING ordered some ounces of human blood, drawn from a healthy person, to be kept until the *serum* and *crassamentum* had fairly parted, I mixed two drachms of the serum with an ounce of lime-water: No change ensued; the mixture continued transparent, and, after forty-eight hours standing, no precipitate could be perceived, while the liquor remained in the glass; but upon pouring it out, a very small quantity of white earthy matter was found at the bottom, which, however, would not effervesce with vinegar.

EXPERIMENT 23.

ABOUT two drachms of the *crassamentum* of the same blood being put into a cup with an ounce of lime-water, and left for five days, did neither totally dissolve, nor turn putrid; a piece of it being then taken out, and spirit of vitriol poured on, an effervescence ensued; the lime which had penetrated, and joined itself to the fixed air of the *crassamentum*, now bursting forth from every part of it, the moment the acid was applied.

So

So that the fixed air appears to be connected chiefly with the red globules, and with that part of the blood called by *Senac* the *lymphæ coagulabilis*; since these two are found to compose the *crassamentum*.

EXPERIMENT 24.

Two ounces of lime-water being put into a tall drinking-glass, about half an ounce of blood was allowed to flow from the vein of a person in health, into the glass with the water: when it had stood six hours, the mixture was all poured out, to about a drachm, which was suffered to remain in the bottom of the glass; on this sediment some spirit of vitriol was dropped, and raised a smart ebullition; the calcareous matter turning white, as it boiled up on the addition of the acid; so that the fixed air is easily detached from fresh blood.

EXPERIMENT 25.

New breast milk, when mixed with lime-water, in the proportion of one to three, in great measure destroyed the acrid taste of the lime, yet did not cause any separation that was immediately perceivable; but after standing twelve hours, the precipitation

pitiation was visible; and, on pouring out the mixture, the sides of the glass were found incrusted with a calcareous matter, which, as well as what fell to the bottom, effervesced violently on the addition of spirit of vitriol.

So that milk contains a large proportion of fixed air, and consequently ought not to be mixed with lime-water, since it must necessarily take off from its activity.

Dr. *Alston* observed very well, that there is scarce any thing that is usually mixed and given along with lime-water, that does not, more or less, destroy its efficacy; for which reason he recommended it always to be taken alone*.

LIME-WATER, when mixed with milk of any kind, prevents it from turning sour; the reason of which is obvious, because, by absorbing and retaining the fixed air, the intestine motion is prevented, whence there can be no change of combination.

I HAVE now finished what was originally proposed; and, I hope, have satisfactorily shewn, that *fixed air* is the cementing principle on whose presence perfect cohesion de-

* Dissertation on quick-lime, p. 41, sect. 11.

pend,

pend, at least in animal and vegetable bodies *; and though the experiments which I have made are very far from exhausting the subject, yet they certainly are sufficient to raise curiosity, and to prompt men of leisure to a further investigation of this important element; which ought not, by any means, to be confounded with the *atmospheric air*: for, excepting its being for a time capable of elasticity, the *fixed air* does not appear to agree, in any other property, with the *common air* which we breathe.

WE know for certain that the *atmospheric air* could not immediately pervade the lime-water, or other fluids, in the manner that *fixed air* plainly appeared to do †: This last,

* I have said *perfect* cohesion; for, as Dr. Hales observes, “Doubtless all the particles of matter whatever do in actual contact cohere; yet since it is found by experiment, that the most solid parts of animals and vegetables yield a vastly greater quantity of air, and less water, than the more lax and fluid parts, it seems therefore, hence reasonable to conclude, that their solidity is principally owing, not to the watery, but to the air and sulphureous particles.” Vol. ii. p. 280.

† That common atmospheric air cannot immediately pervade water, is fully proved by a number of experiments,

last, though perfectly elastic when first set free, yet, in a very little time, loseth its spring, mixeth with the liquid, penetrates every where, and joins with the disunited and scattered particles of the substances dissolved *.

BUT a still more striking distinction between the *fixed* and the *common atmospheric air*, may be remarked in the very different and opposite effects which the two produce in the bodies of living animals.

THE *fixed air*, when set free, and in a state of perfect elasticity, whether it be during the first stage of fermentation, by

experiments, formerly made by M. de Reaumur. See the Mem. de l' Acad. des Sciences, for the year 1714, the 5th article of the memoirs.

* The *air* which flies off from bodies, whether solid or fluid, in the exhausted receiver of an air-pump, is *not* the *fixed air*; for this never departs but when the body to which it belongs either suffers a decomposition, or is dissolving into minute parts.

Thus, if the *mild* volatile alkali, and the *caustic* volatile alkali (*viz.* Sp. cornu cervi per se, and S. Sal. Ammon. cum calce viva) be both inclosed in the same exhausted receiver, the one will throw off as many air-bubbles as the other; though we certainly know that the first contains a large proportion of fixed air, while the second is entirely void of this principle.

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fire

fire *, by effervescence, or by putrefaction †, if it be received into the lungs of any living animal, causeth instant death.

BUT

* Dr. Hales suffocated a sparrow, by putting it into air that had been obtained by distillation from heart of oak. Vol. i. p. 176.

† Accounts of people suffocated by putrid vapour on going down into wells or vaults that have been long stopt up, are extremely common; but there is one instance of the deleterious effect of this kind of vapour related in the History of the Academy of Sciences, for the year 1745, which is very remarkable. A sailor, on board a ship at Rochfort, having inadvertently taken out the bung from a cask full of putrid sea-water, was instantly struck dead, and six others who were in the hold, at some little distance, also fell down, lost their senses, and became convulsed. The surgeon of the ship, being told of the accident, hastened to their relief; but no sooner entered the hold, than he likewise fainted. However, he and the six seamen were, by some means or other, dragged up from the hold into the open air, where they soon recovered.

M. Dupuy, physician to the marine at Rochfort, who relates the story, was desirous of examining the body of the dead man; but it presently grew black, puffed up, bled at the nose, mouth, and ears, and became so exceedingly putrid and offensive, that it was impossible to proceed to the dissection.

Thus it appears that these vapours do not kill by mere suffocation, but that they act at once on the blood, and

BUT the same elastic matter, when received into the stomach, whether thrown off

and destroy its texture in a most surprising and unaccountable manner.

A very little precaution would always secure people from every accident of this fatal nature, since it requires nothing more than to fix an open lanthorn with a lighted candle in it to a pole, or cord, and let it down, or thrust it into the place where there is reason to suspect may be full of noxious vapour. (Such are old wells or vaults, that have been long closed up; wells of ships full of stinking bilge water; cellars or vaults full of liquors, in a state of fermentation.) If the candle continues to burn, people may enter with safety; but if it goes out immediately on being exposed to the noxious vapour, then no person must on any account go in, until the vapour be dispersed, either from the place's being left open for a proper length of time, or by repeatedly throwing in lighted squibs or crackers, which, by their explosion, will presently purify the air.

The following experiments, made by my ingenious friend, Mr. James Kenley, of Belfast, will very properly come in here.

Belfast, Sept. 22, 1765.

“Some days ago I got four puppies, and immediately set about the experiments you recommended, which I made as carefully as I could.

“I thrust an awl into the medulla oblongata of one of the puppies, and kept it as a standard. I killed a second by suffocating it with fixed air, a third with the fumes of burning brimstone, and a fourth with the fumes

off from effervescent mixtures, given in the way of medicine, or extricated from the

of burning charcoal. I opened the thorax of each, and observed that the lungs in the animal killed by the fixed air appeared more collapsed than those of the animal killed by the awl. The lungs in both appeared exactly the same colour. The lungs of the animal killed with the fumes of sulphur were intirely collapsed, and of a very white colour. The lungs of the puppy killed with the fumes of charcoal appeared of a white colour, and quite collapsed; the colour of the lungs in the last animal was not so white as the former. I could not procure a fifth puppy, or would have suffocated it in its own vapour, and observed whether the lungs differed in appearance from any of the others or not.

“ Having observed that Dr. *Hales* could breathe air which passed through cloths dipt in vinegar (*Statistical Essays*, p. 263) much longer than the same quantity of air without such cloths, I imagined that the air in a fixed state might in some way or other be deprived of its acid, and then lose its vivifying power, or spirit, as it is called. In order to know whether animals could breathe fixed air longer with acids suspended in it, I made the following experiments.

“ I inclosed a sparrow in a bladder, the mouth of which was well tied to one of the legs of your air machine. I transferred the air of some pearl-ashes into the bladder; the bladder was immediately distended, and ten minutes after the sparrow died.—I inclosed a second sparrow in a bladder, and tied it as before; but in this I suspended a piece of sponge dipt in vinegar. I charged the

the food in the natural process of alimentary fermentation, is so far from producing any ill effect, that, in the first instance, it often operates like a charm in restraining vomitings, and, in the second, is absolutely necessary for the support of life and health.

With regard to the *atmospheric air*, it is universally known that *no* animal can live long without fresh supplies of it, and those who have lungs cannot exist many minutes without taking in large quantities of this element. But if a very small portion of the same be forced into the vessels, and mixed with the fluids of any living animal, death presently ensues.

So that these two elements seem to be different in their natures, and to have quite distinct provinces with regard to animal life. We have not, as yet indeed, a suf-

the bladder with fixed air, and observed that the sparrow lived near half an hour.—I inclosed a third sparrow, and a piece of sponge dipt in equal parts of volatile vitriolic acid and water as before; the bladder was then charged with air; the sparrow lived for forty-three minutes.—I inclosed a fourth sparrow, and dipt the sponge into equal parts of Glauber's spirit of nitre and water; the sparrow lived for half an hour."

sufficient number of facts to determine *positively* whether they be *originally distinct elements* in nature, or whether the *fixed air* is nothing more than a portion of the *universal aerial fluid*, which is altered, and modified, from its having been united with some other principle.

THIS seems to have been the opinion of Dr. Hales, who looked on fixed air as a portion of the common atmospheric elastic air, deprived of its spring, and reduced to a state of fixity and attraction, by the power of the *sulphur principle* in bodies.

BOERHAAVE was in some doubt what to think concerning the fixed air. “*Dubitatum quandoque, an omne illud quod ita gigneretur foret quidem ejusdem ita naturæ ut eodem nomine aeris elastici appellari debet? an vero corpora certa lege resoluta in partes minimas, ommissa natura sua prima, forte vera transmutatione permutarentur in aerem hunc elasticum, qui dein rursus concretus aliis iterum firma redderet nova corpora? an adeoque præter aerem communem elasticum, aliud illi simile, non idem, in rerum natura obtineret?*” *Element. Chem.* tom. i. p. 532.

BUT

BUT let the original nature be what it will, it appears, from a circumstance peculiar to lime-water, that there is great store of the *cementing principle* always floating in the atmosphere, which is ready to be absorbed by such bodies as have an affinity therewith; for we see that the particles of the dissolved quick-lime, which are nearest the surface of the water, attract the fixed air from the atmosphere, and form crusts, which are nothing more than a pure calcareous earth, such as the quick-lime was before calcination, and which, by the action of fire, may be reduced to quick-lime again.

The first of these is the original nature of the matter, which is supposed to be a continuous substance, and which is supposed to be the cause of the motion of the particles. The second is the nature of the motion, which is supposed to be a continuous motion, and which is supposed to be the cause of the motion of the particles. The third is the nature of the particles, which are supposed to be continuous, and which are supposed to be the cause of the motion of the particles.

SUPPLEMENT.

IT having been laid down by Dr. Hales, that air is the bond of union in salts, and the same thing having been asserted by the baron *de Haller* (see the passage transcribed from him in the note at the beginning of the second essay) I took it for granted that it really was so; and in the former edition, when accounting for the difference between the spirit of *sal ammoniac* made with quick-lime, and that which is made with chalk, I alledged that the quick-lime detained the fixed air of the crude salt as well as the acid, whence the volatile spirit obtained by the distillation could neither effervesce, nor the volatile salt put on the concrete form: but I now find that this theory will not answer, since it appears from experiment, that crude *sal ammoniac* contains no fixed air; for having thrown a drachm of this salt (previously rubbed into a powder in order to make it dissolve quickly) into an ounce and a half of clear lime-water, the solution did not at all abate of
its

its transparency, and not the least sign of precipitation ever ensued.

I ALSO find that common salt does not contain much fixed air, and that nitre has still less of this principle.

A DRACHM of nitre being dissolved in an ounce and a half of clear lime-water rendered it somewhat turbid, and threw up a small quantity of whitish scum on the surface; little flakes of white earth gradually formed themselves, partly fell down to the bottom of the glass, and partly remained suspended in the solution; but the whole of what earthy matter was formed did not exceed the quarter or third part of a grain.

A DRACHM of *common salt* (of the finest sort, such as is generally used for the table) being dissolved in an ounce and a half of clear lime-water rendered it more turbid than the nitre did, threw up more of the white scum, and in the end let fall at least double the quantity of earthy precipitate, there being about half a grain of it which effervesced with weak spirit of vitriol, as did also that which was deposited by the solution of nitre. Now when salt of tartar, or salt of hartshorn, which are both of them replete with fixed air, are mixed
even

even in very small quantities with clear lime-water, the solution instantly becomes turbid, and very soon lets fall a considerable quantity of earthy precipitate.

FROM these experiments it appears, that saline particles do not always require fixed air to bind them together, and that salts may put on the concrete form with a very small quantity, or even altogether without the aid of this principle.

BUT what is very remarkable, fixed air has the power of rendering saline particles incapable of remaining in a state of solution, and of giving them so much solidity that they have the appearance of earth.

DOCTOR *Ferguson* of *Belfast*, who has written an essay on the use of leys and sours in bleaching, which will shortly be published, and which will point out some improvements of very great importance to the staple manufacture of this kingdom*, among other curious experiments has the following.

He dissolved four ounces of pearl ashes in twenty ounces of water, and after filtration laid by four ounces of the clear ley

* *Ireland.*

for a standard; he then transferred factitious air into the remainder from an effervescent mixture, by the means of an apparatus, such as is represented in the plate fig. 5. The ley did not begin to grow turbid till after twelve hours standing; next day a sediment was deposited; at the end of four days he carefully collected and dried the precipitate, which weighed nine grains, and was quite insipid: The ley was much milder to the taste than the standard, and an ounce of it was saturated with a fourth part less of an acid than was required to bring an ounce of the standard to a neutral state.

FROM this experiment we may easily conceive how it comes to pass, that *volatile sal ammoniac* may put on the concrete form, by the aid of the fixed air, which is supplied to it from the chalk, when this substance happens to be used in the distillation.

HAVING sometimes thought that fixed air might possibly have the power of restoring a metallic calx, I tried it in the following manner, but did not find it answer this expectation.

I MIXED

I MIXED two drachms of *minium* with a spoonful of water, and put it into a small phial; the tube of figure 4. was inserted into the mouth of this phial, and fixed there. I then expended about six drachms of salt of tartar, in transferring air into the mixture, but it produced no apparent change of any sort. This being done, the mixture of minium and water was poured into an iron spoon, and placed on the fire; it was kept there for some time, even after the spoon grew red-hot, but the minium still remained in the state of a calx, without any other change than what regarded its colour, for it now turned from a bright red to a dark crimson.

HAVING allowed the things to cool, I then added a little bit of tallow, and again set the spoon on the fire; the tallow soon flamed and burned away, but left the greatest part of the minium reduced to lead, and the remainder changed to a bright yellow powder.

POST-

I mixed two drachms of minimum with a spoonful of water, and put it into a small glass; the tube of figure 4 was inserted into the mouth of this glass, and fixed there. I then expended about six drachms of salt of tartar, in transferring all into the mixture, but it produced no apparent change of any sort. This being done, the mixture of minimum and water was poured into an iron spoon, and placed on the fire; it was kept there for some time, even after the spoon grew red-hot, but the minimum still remained in the state of a salt, without any other change than what regarded its colour, for it now turned from a bright red to a dark crimson.

Having allowed the things to cool, I then added a little bit of tallow, and again let the spoon on the fire; the tallow soon flamed and burned away, but left the greater part of the minimum reduced to lead, and the remainder changed to a bright yellow powder.

P O S T S C R I P T

THE foregoing sheets were all printed off, and ready for publication, when the author received a letter, dated *Longreach, April 9, 1767*, and a journal, from Mr. *Alexander Young*, surgeon of his majesty's ship *Jason*, containing a general account of the state of weather and diseases, during a voyage to the *Falkland Islands* on the coast of *Patagonia*, together with a particular detail of four scorbutic cases, wherein wort was given according to the proposal in the fourth essay.

THIS voyage was so uncommonly healthy *, that the journal contains nothing

* The *Jason's* company consisted of one hundred and eighty, including twenty-five marines, but no boys: out of this number they buried but three during the whole voyage, from 25th *October 1765*, to 20th *March 1767*. One of these died of a putrid fever; the second went off in the fit of an apoplexy; and the third killed himself by excessive drinking. It appears indeed, from the journal, that the utmost pains were taken from the beginning, to preserve the people in health. Once a week the chests were examined, to see that every man had

new or remarkable, except what regards the management of the scorbutic cases, which are here extracted, and given precisely in the words of Mr. Young, who mentions in his letter, that as seamen in general are so very averse to every thing in the way of experiment, he could not have prevailed on the men to take the wort, if they had not observed the officers drink it repeatedly, without inconvenience, by way of preservative.

THERE was no opportunity of determining the genuine effects of the wort, until the ship was on her return home *; for the only one who drank it on the passage out, and who recovered, was also supplied by the captain with apples and oranges; and those who drank it for such

had his stock of cloaths; and they were obliged to keep themselves always clean and well dressed, under penalty of having their allowance of spirits stopt. The ship was well aired between decks, and fumigated with tar and brimstone from time to time; and during the whole passage both out and home, elixir of vitriol was mixed with the water, two spoonfuls to a puncheon.

* The *Jason* sailed from *Port Egmont* in the *Falkland Islands* on the 18th *January*, and arrived in the *Downes* the 20th *March* 1767.

scorbutic

scorbutic complaints as appeared among them, during the winter, at *Port Egmont*; likewise used the wild celery, which grows there in great abundance, and they never took the wort regularly; but in the following cases the patients had no aid from fresh vegetable diet.

“THEIR breakfast was the sea-biscuit boiled up with wort and sugar; for dinner, at some times, what could be spared from the officers table, and at other times portable soup, thickened with barley or rice, and seasoned with shallots or garlic; for supper, rice and currants, sago, or salop, with *Madeira*.”

THE four all began the wort at the same time; two of them, it appears, had been received from the *Carcass* sloop; just before the *Jason* sailed for *England*.

“THE wort was made fresh every day, in the proportion of three measures of boiling water to one of the ground malt; it was allowed to stand close covered till cold, and then strained off.”

An EXTRACT from a Medical Journal kept by Mr. ALEXANDER YOUNG, Surgeon of His Majesty's Ship JASON, Captain JOHN MACBRIDE, Commander.

“WILLIAM LARDER, aged twenty-nine, formerly of a good habit of body, *February 1, 1767*, complains of great lassitude; that he finds himself fatigued by walking but a little while; his face is pale and yellowish; his mouth pretty clean, owing perhaps to the elixir of vitriol we daily put in our water; his gums are a little swelled and spongy; his breath is very offensive; his legs swell, and pit when pressed with the finger; they are covered with blue spots of different sizes like bruises, with two ulcers, which discharge a thin bloody ichor, and have a black mortified appearance; his legs are more swelled at night than in the morning; he is generally costive; his appetite is good, and his pulse pretty regular.

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“ His legs are ordered to be steeped with the common fermentation, and the ulcers dressed with the common dressing.

“ GAVE him half a pint of the wort in the morning, and half a pint in the evening.

“ 3d, GAVE him one pint in the morning, and half a pint in the evening.

“ 7th, GAVE him a pint morning and evening.

“ 8th, THE wort purged him last night, but he took the same quantity to-day, without having any such effect. Finds himself something better.

“ 12th, GAVE him a pint in the morning, another in the middle of the day, and a third at night.

“ 20th, He looks healthier, his legs are not so much swelled, the ulcers seem inclinable to heal, having left that black bloody appearance. Gave him a quart of the wort in the morning, a pint at noon, and another at night.

“ 28th, HE finds himself greatly better, the ulcers being almost healed, and the swelling gone, except a little in the evening; the skin is peeling off his legs. Gave

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him a quart in the morning, one at noon, and one at night.

“ *March 6th*, HAs no complaints, and returns to his duty, but continues to drink the wort, the quantity of which is to be lessened by degrees, until he leaves it off entirely.”

“ JOHN CARROL, aged thirty-five years, formerly healthy, brought a pox with him from *England*, which has eluded the force of all the medicines given him, owing, perhaps, to the man's own negligence and intemperance, joined to the scorbutic habit which he acquired during the winter.

“ HE was very ill of the scurvy during the winter, but got better by drinking the wort, eating wild celery, and using exercise on shore; the calfs of his legs were quite indurated, and black at that time.

February 1, HE has now several ulcers upon him, in his legs and arms, which are very offensive; a large hard swelling on his cheek; his testicles are swelled, hard, and quite insensible; his gums are rotten, black, and bleed frequently; his breath stinks horribly; he is quite emaciated,

ciated, and ready to faint every step he takes; he has no appetite, is greatly dejected, and his pulse very low.

“ THE ulcers were dressed dry.

“ GAVE him half a pint of the wort in the morning, which directly brought on a looseness with fainting, which, however, soon stopped, on his taking some doses of the *electuarium escordis*, dissolved in cinnamon-water, together with mulled wine. Gave him twenty drops of the acid elixir of vitriol along with his wort, and three times a day a glass of the following bitter wine.

R Cort. Peruvian. crasse pulv. unicas duas
—— Limonum fescunciam vini Ma-
deirens. lib. duas. M.

“ 3d, HE is better; gave him half a pint of wort twice a-day.

“ 10th, HE finds himself stronger, and not so liable to faint. The swelling on his cheek looks red and inflamed. Applied a poultice of oatmeal with a little oil.

“ 20th, STRONGER, has a better appetite; ulcers look better; the tumour on his cheek broke of itself; the quantity of
matter

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matter but small, blackish, and very offensive. Gave him a pint of wort twice a-day.

" *March 1*, CONTINUES mending; his cheek has degenerated into a foul looking ulcer like the rest. Gave him three pints of wort in the day.

" *10th*, HAS almost quite recovered his strength, and eats heartily. The ulcers begin to discharge a thicker matter, and have not so bad an appearance.

" *16th*, CONTINUES to mend. Gave him two quarts of wort in the day.

" *20th*, ARRIVED in the *Downes*. He is greatly mended in his appearance, and health in general. Judged necessary to let him have the benefit of the air on shore."

" WILLIAM ROGERS, marine, aged about twenty-four, of a thin weakly habit of body, has been sickly all winter.

" *February 1*, COMPLAINS of great weakness, pain, and swelling of his knees; his legs are drawn up so, that he cannot stretch them without pain; his face is of a dark yellowish colour; he is quite emaciated, being scarce any thing but skin and bone;

bone; his pulse low, and rather quick; he is generally loose.

“ His knees were fomented twice a-day with the common fomentation, to which was added an eighth part of vinegar; and rubbed with a camphorated liniment. He likewise took the bitter wine, and half a pint of wort twice a-day.

“ 6th, GAVE him half a pint thrice a-day.

“ 10th, GAVE him a pint twice a-day.

“ 11th, THE wort purged him last night, but ceased immediately on taking twenty drops of *tinctura thebaica* in two spoonfuls of cinnamon-water.

“ 12th, GAVE him half a pint three times a-day.

“ 18th, HE is much better, can stretch out his legs, and walk pretty well. Gave him two pints and a half in the day.

“ 26th, CONTINUES mending. Gave him a pint three times a-day.

“ *March* 9th, Now finds himself pretty well, and is returned to his duty; but still continues to drink the wort, in a smaller quantity.

“ WILLIAM WATERS, aged thirty-six, a strong man, and formerly very healthy,

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healthy, was afflicted with scorbutic complaints all winter. *February 1*, Complaints of weakness, falling away in his flesh, and ulcers on his legs; dressed the ulcers dry, and gave him three half pints of the wort in the day.

“ 6th, GAVE him a pint thrice a-day.

“ 20th, GAVE him two quarts in the day.

“ 20th, GAVE him three quarts in the day.

“ *March 10th*, ULCERS healed up, has no complaints, and looks remarkably fat and fair.

F I N I S.